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ABSTRACT

This publication presents a suggested inservice training program for safety in the laboratory for secondary school science teachers. It consists of three parts. Part one discusses administrative guidelines. Part two consists of 14 lesson plans for lectures in the training course for teachers. Each of these lesson plans consists of an overview, table of contents, and text in a script format. Most of these also have reference citations and a slide script. Each lecture lesson plan is complete and independent of the others to facilitate changes in the desired sequence. Part three has four workshop lesson plans for the course. Each workshop consists of a lesson plan with overview, listing of contents, text in script format, exhibits for background or reference, and worksheets for exercises. Directions are also provided. Each workshop is tied to a lecture lesson. Five appendices are presented at the end of the publication: (1) Audio-Visuals; (2) Library Resources; (3) Dictionary of Resources; (4) Program Evaluation; and (5) Trainee Evaluation. (HM)

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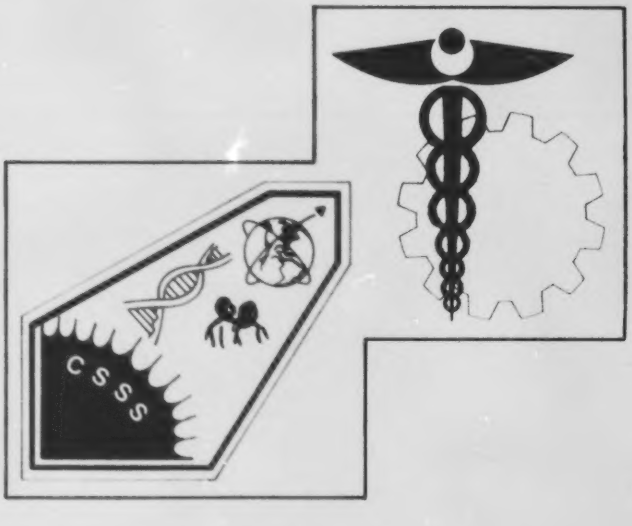

Safety in the School Science Laboratory

INSTRUCTOR'S RESOURCE GUIDE

U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety & Health
Division of Training & Manpower Development
Cincinnati, Ohio 45226

August 1977

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CONTENTS

ACKNOWLEDGMENTS vii

PART I. ADMINISTRATIVE GUIDELINES

INTRODUCTION 1
    How to Use This Manual 1

TRAINING PROGRAM ELEMENTS 3
    Conference of State Science Supervisors 3
    State Plans for Safety Training 4

PART II. LECTURE LESSONS

1. SCOPE OF THE PROBLEM (30 minutes). 1-1
2. NEEDS ASSESSMENT (30 minutes). 2-1
3. LEGAL ASPECTS OF CLASSROOM SAFETY (15 minutes) 3-1
4. STUDENT INVOLVEMENT IN SAFETY PROGRAMS (30 minutes). 4-1
5. EYE AND FACE PROTECTION (45 minutes) 5-1
6. PROCEDURES FOR HANDLING CHEMICAL REAGENTS (45 minutes) 6-1
7. STORAGE AND DISPOSAL OF CHEMICAL REAGENTS (30 minutes) 7-1
8. LABELING (20 minutes). 8-1
9. HANDLING GLASSWARE (30 minutes). 9-1
10. BIOLOGICAL AND ANIMAL HAZARDS (30 minutes) 10-1
11. VENTILATION (30 minutes) 11-1
12. FIRE CONTROL (30 minutes) 12-1
13. LABORATORY HARDWARE (30 minutes) 13-1
14. RECORDKEEPING (20 minutes) 14-1

PART III.WORKSHOP LESSONS

W-1. SAFETY PROGRAM PLANNING (50 minutes) W-1
W-5. EYE AND FACE PROTECTION (50 minutes) W-5
W-8. LABELING CHEMICALS (50 minutes). W-8
W-13. SAFETY EQUIPMENT (2 hours) W-13

APPENDICES

A. AUDIO-VISUALS A-1
B. LIBRARY RESOURCES B-1
C. DIRECTORY OF RESOURCES C-1
D. PROGRAM EVALUATION D-1
E. WALK-THRU SURVEY E-1
F. TRAINEE EVALUATION (reserved). F-1

Contents (continued)

LIST OF EXHIBITS

Exhibit 1. SCIENCE SAFETY TRAINING GOALS 6
2. STATE TRAINING PLANS 7
3. TRAINING COURSE DESCRIPTION. 8
4. TRAINING COURSE MATERIALS 9
5. TRAINING COURSE DELIVERY 10

4-1. PROFILE OF A SAFETY PROFESSIONAL 4-17
4-2. SAMPLE STUDENT SAFETY CONTRACT 4-18
4-3. SAMPLE LABORATORY SAFETY RULES 4-19
4-4. SOME CURRENT STUDENT PROBLEMS 4-20

5-1. MODEL SCHOOL EYE SAFETY LAW 5-22
5-2. STATES WHICH HAVE ENACTED LAWS 5-24

6-1. EXAMPLES OF INCOMPATIBLE CHEMICALS 6-30

7-1. CONSTRUCTION AND FIRE PROTECTION REQUIREMENTS FOR LABORATORY UNITS 7-24
7-2. CONCENTRATION IN AIR AND WATER ABOVE NATURAL BACKGROUND 7-25
7-3. ALLOWABLE CONCENTRATIONS ABOVE BACKGROUND. 7-31

8-1. HAZARD DIAGRAM 8-17
8-2. NFPA HAZARD CODING SYSTEM 8-18

10-1. MICROORGANISMS AND THE DISEASES THEY CAUSE 10-22
10-2. BIOHAZARDS SIGN 10-23

11-1. RECOMMENDED MINIMUM AVERAGE HOOD FACE VELOCITIES 11-26

14-1. SUPERVISOR'S ACCIDENT REPORT 14-21
14-2. RECORDKEEPING REQUIREMENTS UNDER THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970. 14-23

W-1-1. RESPONSIBILITIES UNDER THE OSH ACT W-1-11
W-1-2. OCCUPATIONAL SAFETY AND HEALTH REGULATIONS W-1-12

W-5-1. REGULATIONS FOR EYE AND FACE PROTECTION UNDER THE OSH ACT W-5-7
W-5-2. RECOMMENDED EYE AND FACE PROTECTORS FOR USE IN INDUSTRY, SCHOOLS, AND COLLEGES. W-5-9
W-5-3. JOB ANALYSIS W-5-11

Contents (continued)

W-8-1. SAMPLE INSPECTION SHEET FOR CONTROLLED CHEMICALS. W-8-7
W-8-2. NFPA RECOMMENDATIONS FOR LABELING CHEMICALS W-8-9
W-8-5. HAZARD RATINGS AND SIGNAL WORDS W-8-11
W-8-5a. HEALTH RELATED STATEMENTS W-8-17
W-8-5b. HEALTH HAZARD ACTION STATEMENTS W-8-18
W-8-5c. FIRE AMPLIFYING STATEMENTS. W-8-19
W-8-5d. FIRE HAZARD ACTION STATEMENTS W-8-21
W-8-5e. REACTIVITY AMPLIFYING STATEMENTS W-8-22
W-8-5f. REACTIVITY HAZARD ACTION STATEMENTS W-8-23
W-8-5g. FIRST AID STATEMENTS W-8-25
W-8-5h. STATEMENTS SPECIFYING SPECIFIC DISPOSAL INSTRUCTIONS. . . W-8-26
W-8-5i. SAMPLE LABEL W-8-27

W-13-1. SUGGESTED ITEMS FOR SAFETY EQUIPMENT CHECKLIST. W-13-7
W-13-2. HAZARD RECOGNITION "EQUIPMENT". W-13-8
W-13-3. HAZARD EVALUATION EQUIPMENT W-13-9
W-13-4. HAZARD CONTROL EQUIPMENT. W-13-10

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Commonwealth of Virginia, Department of Education (Exhibit W-13-1)
International Safety Academy (Exhibit W-5-3)
National Fire Protection Association (Exhibit 8-2, W-8-2)
National Society for the Prevention of Blindness (Exhibit 5-1)

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PART I. ADMINISTRATIVE GUIDELINES

INTRODUCTION

Safety in the School Science Laboratory is a suggested In-Service Training Program, cooperatively developed by representatives from the Council of State Science Supervisors (CS^3) and the National Institute for Occupational Safety and Health (NIOSH).

The complete training program includes the following elements:

Conference of State Science Supervisors
State Plans for Safety Training
Training Course for Teachers

This manual is the working paper. Part I contains administrative guidelines. Part II consists of lesson plans for lectures in the training course for teachers. Part III has workshop lesson plans for the course. Appendices provide supplemental course material.

How to Use This Manual

Part I (Administrative Guidelines)

The primary audience is the State Science Supervisor. Secondary audiences include instructors, resource people, and other training personnel involved in the program. All audiences should read this material carefully, taking special note of the information that is directly applicable to their own roles.

Part II (Lecture Lessons)

Primary audiences are instructors and resource people. However, all training personnel should thoroughly examine the contents.

Part III (Workshop Lessons)

The primary audience is the teacher trainee. All training personnel should study the material and at least mentally complete the exercises and worksheets. Copies should be made for trainees.

Appendices

Appendix A (Audio-Visuals) is for planning on the part of State Science Supervisors, instructors, and other training personnel. Included are audio-visual critiques (Worksheet A-1 and A-2) to be reproduced and used for film showings and other AV sessions.

Appendix B (Library Resources) is for all program participants. This should be reproduced and distributed to teacher trainees as a reference for at least the lesson on Safety Program Planning (Workshop W-1).

Appendix C (Directory of Resources) is also for all participants in the training program. It should be made available to teachers with Appendix B.

Appendix D (Program Evaluation) is intended primarily for State Science Supervisors, but all training personnel should be concerned with evaluation topics and procedures. The sample training certificate (Exhibit D-1) may also interest teacher trainees.

Appendix E (Trainee Evaluation) is reserved for supplements by CS^3, NIOSH, and others in the form of possible instruments, test items, and the like.

As experience accumulates with the training program, additional course material may also be added.

TRAINING PROGRAM ELEMENTS

This section of the administrative guidelines provides some details about the major elements of the CS^3 - NIOSH In-Service Training Program on Safety in the School Science Laboratory.

Conference of State Science Supervisors

Combination training and review sessions were held on July 19-21, 1977, in greater Cincinnati, Ohio, to go over the program presented in this manual and consider suggestions for improvements.

The sessions were coordinated by the Executive Secretary of CS^3 amd the NIOSH Project Coordinator in the Division of Training and Manpower Development. Participants included other NIOSH training personnel and consultants.

This manual was updated after the conference, but time did not permit the inclusion of all desired changes. Planning for additional course material is already underway.

State Plans for Safety Training

Each State Science Supervisor may wish to design a detailed program to manage and implement safety training for his or her high school teachers.

The state plan should probably include objectives for training every high school science teacher by the schedule shown in Exhibit 1.

Each plan should be geared to the needs and requirements of the particular state, considering not only educational aspects but also pertinent safety and health rules and regulations.

Reference documents include the Federal Occupational Safety and Health Act of 1970 and corresponding regulations, state laws and regulations of this type (if approved and available), and other similar or related standards.

Each State Science Supervisor should have desk copies of all applicable safety and health requirements.

The essential items to cover in the state plans are briefly outlined in Exhibit 2.

Training Course for Teachers

The rest of this manual is devoted to a core course in safety in the laboratory for secondary school science teachers. The course is designed to be presented in many ways, according to the training circumstances that are most convenient for state and local supervisors.

Lessons and other learning experiences may be tackled separately or in batches, preferably with groups of teachers meeting together at regular intervals. If necessary, teachers who are unable to attend all of the meetings could be given copies of the instructional material for self-study, but this is not generally recommended for obvious reasons.

Lecture Lessons (Part II)

Each of the 14 lesson plans for lectures consists of an overview, table of contents, and text in a script format. Most of these also have reference citations and a slide script. Open discussion is strongly encouraged.

Each lecture lesson plan is complete and independent of the others to facilitate changes in the desired sequence.

Workshop Lessons (Part III)

Each of the 4 workshops consists of a lesson plan with overview, listing of contents, text in script format, exhibits for background or reference, and worksheets for exercises. Directions are also provided.

Each workshop is tied to a lecture lesson, as indicated by the label. Workshop W-1 should follow Lesson 1, Workshop W-5 should follow Lesson 5, etc. Preferably, there should be at least one day between lectures and related workshops to allow trainees to complete the exercises in their own work areas and discuss the results with other colleagues before reviewing them in group sessions.

Worksheets may be mailed to training supervisors or instructors, but this is not encouraged. In any case, at some point in the training course, group discussion of the results is necessary. The value of the exercises is in doing them and getting feedback and new ideas. They should not be graded or criticized negatively.

Appendices

Appendices A through D are "stand-alone" sections with brief explanatory text and other information.

Appendix A includes a critique form to be completed by all trainees for each audio-visual training aid reviewed (except for lecture slides).

Appendices B and C are supplements to Workshop W-1.

Appendix D includes a sample training certificate.

Appendix E includes a Walk-Thru Safety Survey for the School Science Laboratory.

Appendix F is reserved for trainee evaluation.

Summary

Summary information about the training course for teachers is presented in the form of exhibits. Exhibit 3 is a Training Course Description. Exhibit 4 deals with the details of Training Course Materials. Exhibit 5 outlines suggestions for Training Course Delivery.

EXHIBIT 1. SCIENCE SAFETY TRAINING GOALS

Year	Secondary School Teachers Trained (Percentage)
1977	1
1978	5
1979	25
1980	75
1981	90
1982	100

EXHIBIT 2. STATE TRAINING PLANS

Item	Recommendations
Approval	Chief State School Officer
Arrangements	Local administrative approval for teacher attendance Records of attendance and certificate awards Quarterly and annual reports to the Council (CS^3)
Certificates	Provided by CS^3 - NIOSH upon receipt of reports
Evaluation Plan	Performance of unit objectives by trainees to the satisfaction of any instructor
Materials	CS^3 - NIOSH training package
References	CS^3 - NIOSH training manual Federal, state, and local regulations
Resources (optional choices)	State and local safety and health agencies Teacher training departments in colleges Textbook publishers Professional organizations Journal editors Equipment and other suppliers Other occupational safety and health professionals
Training Personnel Criteria	Completion of CS^3 - NIOSH training course Knowledgeable in high school laboratory safety Teaching experience in science subject areas
Training Sessions	Conferences, courses (credit or non-credit), ITV, meetings, or workshops Minimum time indicated in the CS^3 - NIOSH course Sequence to be determined by training personnel Introduction by awareness techniques Opportunities for trainee questions and answers

EXHIBIT 3. TRAINING COURSE DESCRIPTION

Item	Suggestions
Purpose	Prepare school science teachers to understand and apply basic principles of laboratory safety.
Objectives	1) Prevent injury-producing accidents in school science activities. 2) Conduct a safety investigation of the science laboratory and preparation room, using a checklist to detect unsafe conditions. Report results to appropriate school authorities. 3) Demonstrate knowledge and proper techniques of using 10 pieces of common safety equipment. 4) Show an awareness of science laboratory safety in planning, conducting, and evaluating student coursework and related activities. 5) Promote teacher and student involvement in science safety.
Length	16 Instructor-Trainee Contact Hours 14 Lecture Lessons (about 8 hours) 4 Workshop Lessons (about 5 hours) 3 Audio-Visual Sessions (about 3 hours) Laboratory and workshop lessons may require additional practice and preparation time.
Instructors and Resource People	State and Local Science Education Supervisors Occupational Safety and Health Professionals College Teaching Faculty in Related Disciplines
Credit and Sponsors	A certificate and 1.6 Continuing Education Units (CEUs) will be awarded to each trainee who completes the course satisfactorily. The sponsors are the Council of State Science Supervisors (CS^3) and the National Institute for Occupational Safety and Health (NIOSH).

EXHIBIT 4. TRAINING COURSE MATERIALS

Item	Description
* Manual	Administrative guidelines, including suggestions for course delivery. Lesson plans for lectures and workshops, including overviews, outlines, text, references, and practical exercises with worksheets and exhibits. Appendices for audio-visual aids, library resources, directory of resources, and program evaluation.
Audio-Visual Aids	* Set of 35mm slides Slide script included in related lesson plans. See also Appendix A in the training manual.
* Supplemental Packet	NIOSH publications, including Fact Sheets Training Literature U.S. Occupational Safety and Health Act of 1970 Various Publications Lists and References
Equipment and Related Supplies	State and local training supervisors will insure that trainees have access to the 10 pieces of safety equipment they must be able to use. See Workshop W-13 in the training manual.
Handouts	Any part of the NIOSH material may be reproduced for distribution in any quantity. See Acknowledgments for restrictions about copyrighted material. See Workshop Lesson Plans and Appendices A - E for materials needed by trainees.

* NIOSH will furnish each State Science Supervisor with 1 copy. An unbound "master" of the training manual will also be provided for use in further reproduction.

EXHIBIT 5. TRAINING COURSE DELIVERY

Item	Suggestions
Work Plan	Prepare detailed task/time schedule well in advance.
Agenda	Review training manual for requirements. Prepare tentative agenda for training sessions. Schedule related lecture and workshop lessons at least 1 day apart. See Appendix A for audio-visual sessions. See Appendix D for program evaluation.
Training Personnel	Line up instructors and resource people. Prepare and distribute written statements of responsibilities and expectations.
Materials	Reproduce, assemble, and distribute copies needed. Training Manual (to training personnel) Workshop Lessons (by set or by lesson) Slides (by complete set or by lesson) Other AV Aids and Critiques (see Appendix A) Program Critiques (see Appendix D)
Equipment and Supplies	Obtain and allocate (or confirm local availability of) safety equipment described in Workshop W-13.
Facilities	Line up suitable facilities for training. Request and confirm AV equipment and operators.
Notices	Prepare and distribute program announcements.

PART II. LECTURE LESSONS

SCOPE OF THE PROBLEM NO. 1

METHODS Lecture **LENGTH** 30 Minutes

PURPOSE To provide an assessment of school science laboratory safety and health needs

OBJECTIVES

Enable the teacher to --

1) Assess the magnitude of the health and safety problem
2) Identify the nature of the hazards found in school science laboratories
3) Engender a positive attitude concerning safety

SPECIAL TERMS

Biological hazard
Chemical hazard
Ionizing radiation
Non-ionizing radiation
Physical hazard
Pneumonitis
Safety investigation
Systemic poisons
Toxicology

INSTRUCTOR MATERIALS

Lesson plan

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 1-3

UNDERSTANDING THE IMPORTANCE OF SAFETY 1-5

Teacher's Viewpoint 1-6

Student's Viewpoint 1-7

School's Viewpoint 1-8

SAFETY AND HEALTH HAZARDS 1-9

Chemical Hazards 1-10

Biological Hazards 1-11

Physical Hazards 1-12

SAFETY MOTIVATION 1-14

School System Administration 1-14

Instructors 1-14

Students 1-15

DEVELOPMENT OF A SAFETY PROGRAM 1-16

LESSON SCOPE OF THE PROBLEM NO. 1

NOTES	INSTRUCTION
"Stop, Safety First in Science Teaching" North Carolina Department of Public Instruction	INTRODUCTION Any modern science program has a responsibility for teaching students about the nature of the scientific enterprise. Students have a right to learn how to think scientifically and solve problems through the active use of science processes. Students should have ample opportunities to engage in scientific work through laboratory or other "hands-on" activities. These concrete experiences are necessary for prime results at the elementary and advanced levels of science learning. With the trend of science education toward more activity-oriented work and more involvement of students in the processes of science, it is essential all involved in the science instruction program develop a positive approach to a safe and healthful environment in the laboratory. Safety and health should be an integral part of the planning, preparation, and implementation of any science program. An experimental science program possesses certain potential dangers. Yet, with careful

LESSON NO. 1

NOTES	INSTRUCTION
	planning, most potential dangers can be coped with safely in an activity-oriented science program. The responsibility for safety and the enforcement of safety regulations and laws in the science classroom and laboratory is that of the principal, teacher, and student--each assuming his/her share. Carelessness and a negative or apathetic attitude toward safety are the major causes of accidents. Recognition of health and safety problems has crystallized since the passage of the Occupational Safety and Health Act of 1970. This act requires that certain precautions be observed to protect the health and safety of employees on the job. The employee designation includes all teachers employed by private schools and all teachers employed by public school systems in states that have state occupational safety and health plans accepted by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor. Even if certain safety and health precautions were not mandated by law, there are moral, ethical, social, and legal reasons for demanding that high

LESSON	NO. 1
NOTES	**INSTRUCTION**
	school science laboratories be made as safe as possible for instructors and students alike. Legally, school districts can be held liable for injuries suffered by a student in a high school laboratory. It is also deemed by society to be morally, ethically, and socially unacceptable to take unnecessary chances with the lives of young people. The school must provide an educational experience. Unnecessary and undeserved injuries should not be a part of that education. UNDERSTANDING THE IMPORTANCE OF SAFETY Safety and health training in the high schools and universities has been a neglected area. Safety and health studies are often considered to be ancillary areas of study not directly concerned with the subject at hand. They

NOTES	INSTRUCTION
	should not be ancillary areas. Safety and health considerations should be as important as any other material taught in high school science laboratories. Teacher's Viewpoint Teachers have an obligation to instruct their students in the basic safety practices required in science laboratories. They also have an obligation to instruct them in the basic principles of health hazards that are found in most high school science laboratories. As existing knowledge of the effects of common chemical compounds and physical manifestations have on the human organism grows, this knowledge must be conveyed to the individuals exposed to them. It does not matter if the exposed individuals are students. What better time is there to impress upon minds the need for caution and preparation when working in science laboratories? Instructors must accept safety and health study areas as being as much a part of the science curriculum as the fact that hydrogen and

LESSON	NO. 1
NOTES	INSTRUCTION

oxygen, when combined in certain proportions, will form water.

Student's Viewpoint

Getting students to appreciate the need for studying laboratory safety and health material should not be overly difficult. Personal danger is something to which they can relate. Generally individuals will tend to ignore personal danger from situations or things over which they exercise control. Students must be taught that knowledge and preparation are the keys to controlling science laboratory hazards. Knowledge is a fluid commodity in this area. What may be known about a chemical compound today may not be valid tomorrow because the compound may have undergone some physical or chemical change in the interim or our knowledge and understanding of its behavior may have increased.

Learning to prepare properly and research properly are skills that carry over into areas other than science.

LESSON NO. 1

NOTES	INSTRUCTION

Schools' Viewpoint

School systems must appreciate the need for establishing safety and health instruction as a fundamental part of a science curriculum. The large number of lawsuits instigated over injuries to students in school science laboratories emphasizes the need for requiring safe practices from both students and teachers.

At the same time, however, it should be realized that not all accidents and personal injuries occur as a result of unsafe practices.

There is presently no federal law requiring safety and health programs for the protection of the students in schools. The Occupational Safety and Health Act of 1970 requires employers to provide safety and health protection for teachers and other school system employees. Some states (Wisconsin, for example) require school systems to provide specific protection for students in certain areas, i.e., eye protection for students working in laboratories or vocational education shops.

LESSON	NO. 1
NOTES	**INSTRUCTION**

SAFETY AND HEALTH HAZARDS

Safety problems have been recognized and understood for many years. In the science laboratory, most of the safety problems are known and can be guarded against. That does not mean that proper precautions are always observed, however. Occasionally new safety hazards appear in science laboratories because of the nearly infinite variety of operations that can be conducted. New chemical combinations can result in fire or explosion or a toxic product. Known chemical combinations carried out under abnormal conditions of temperature or pressure can also have unexpected results.

On the other hand, health hazards in school science laboratories or any science laboratories have not, for the most part, received the attention they have deserved until recently. The health effects of exposure to the chemical, physical and biological hazards of science laboratories have not been appreciated because their effects are often difficult to measure and may not appear until years after the exposure.

Now that the effects of exposure to these hazards are known, there could be very little justification for not including instruction on such hazards in the school science curriculum.

Chemical Hazards

Many chemical reagents found in the high school chemistry laboratory can be chemical hazards in some fashion or other. Acids and caustic materials are corrosive to the skin and mucous membranes. Exposure to organic solvents can result in any number of harmful effects. Chemical pneumonitis, liver damage, and kidney damage have all been reputed as resulting from exposure to various organic solvents.

Many common chemical reagents are potent systemic poisons. Arsenic, potassium and sodium cyanide, and sodium fluoride are just a few examples of powerful systemic poisons that are commonly found in science laboratories.

Hazardous metals

Many of the metals used in science laboratories are hazardous to exposed personnel. Some

LESSON NO. 1

NOTES	INSTRUCTION
	of the metallic elements are considered to be carcinogens. Chromium, nickel, and arsenic fall in this group.
	Many of the metals affect the central nervous system. Mercury, lead, cadmium, and cobalt are members of this group. Other target areas of the body affected by metals include the respiratory system, the gastrointestinal tract, the cardiovascular system, the liver, and the kidneys.
Chemical toxicology	The study of chemical toxicology is a complex but rewarding subject. Every school science laboratory course should have some basic instruction in the fundamentals of chemical toxicology.
	Biological Hazards
	Experimental work that involves animals and microorganisms presents the possible hazard of infection to the individuals performing the work. Accidental infection by a pathogenic microorganism is a very real hazard in science laboratories. The scientific literature contains a

NOTES	INSTRUCTION
	number of reports of laboratory acquired infections and deaths resulting from them. The need for instruction on the safety precautions that must be observed when working with biological materials is of great importance. Frequently these types of projects are undertaken by students as individual research projects. They, too, must be made aware of safety and health instruction and of its importance in science.
	Physical Hazards
	Physical hazards in science laboratories are generally confined to radiation in its various forms. Ultraviolet light, a type of non-ionizing radiation can be a definite hazard in school science laboratories. Since it affects the eye, overexposure to ionizing radiation, such as alpha, beta, gamma and x-ray, can also be a very real hazard if used improperly.
Ionizing radiation	Ionizing radiation can be hazardous to many different organs of the body. If

LESSON	NO. 1
NOTES	**INSTRUCTION**
	ionizing radiation is used in a school science laboratory, a specific safety program must be established. State and federal licensing regulations require that all users of radioactive materials establish adequate safety programs covering the acquisition, storage, use, and disposal of radioactive materials.
Lasers	Lasers are coming into more frequent use in school science programs. Because of the coherent nature of the laser beam, exposure to one can result in physical damage to the body. The eye is the organ most sensitive to the laser beam. The most likely type of eye damage is thermal damage to the retina. Skin damage may also result from laser beam exposure. The laser beam produces skin lesions which resemble thermal burns.
Microwave radiation	Microwave radiation is another type of non-ionizing radiation that can present hazards to personnel. Exposure to microwave radiation can result in both eye and skin damage.

LESSON NO. 1

NOTES	INSTRUCTION
	SAFETY MOTIVATION

SAFETY MOTIVATION

School System Administration

School administrators should operate their schools in as safe a manner as possible. Injured students and damaged buildings do little to increase public confidence in the particular school system involved. For private schools insurance costs may become prohibitive if the school becomes a recognized source of insurance claims.

It is becoming more prevalent for school systems to be held legally liable in student injury cases.

Instructors

Teachers play the most important role in insuring a safe and healthful learning environment for the students. They must be trained in the philosophy of safety and health programs as well as the technical content of such programs. They need to be taught and encouraged to

NOTES	INSTRUCTION
	understand that safety and health training are important areas of the science curriculum and useful in other aspects of life.
Instructor legal liability	A source of motivation for the teacher is their potential legal liability for injuries suffered by students under their care. Teachers have two primary duties - the duty of instruction and the duty of supervision. Courts have held that if a teacher fails to carry out either of these duties he or she may be legally liable for any injuries that result. Failure to provide adequate safety and health instruction or provide adequate laboratory supervision are failures to adequately perform the primary duties of an instructor.
	Students
Student motivation	Student motivation in any area of education is a critical factor in the learning process. Emphasizing the importance of safety and health considerations by devoting substantial class time to these areas should help. The current popular preoccupation with matters of industrial safety

and health may also serve as a motivational spur.

Students perhaps will find a discussion of toxicology interesting, informative, and beneficial. The possibilities for working this material into the science curriculum are innumerable and limited only by the imagination of the instructor.

DEVELOPMENT OF A SAFETY PROGRAM

Voluntary safety programs are often ineffective. Individuals working in laboratories occasionaly take shortcuts, circumvent safety rules, and take risks to do their jobs. The responsibilities shouldered by school administrators and school teachers require that any school safety program be supported and encouraged by the administration.

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

NEEDS ASSESSMENT NO. 2

METHODS Lecture and Discussion **LENGTH** 30 minutes

PURPOSE Develop understanding and appreciation of the importance of preliminary preparation for laboratory work.

OBJECTIVES Enable the trainee to ...

1) Identify and remedy textbook errors.
2) Discuss the effect of physical layout on experimental procedures.
3) Plan special instruction and pre-exercise demonstrations.

SPECIAL TERMS

Carcinogen
Common sense
Egress
Experimental principle
Health hazard
Ingress
Industrial hygiene
Personal protective equipment
Safety hazard
Toxicology

INSTRUCTOR MATERIALS Lesson Plan

Chalkboard, Chalk, Eraser

TRAINEE MATERIALS Note-taking

CONTENTS

INTRODUCTION 2-3

EVERYBODY HAS SOME WORK TO DO 2-5

    Authors and Publishers 2-5

    Teachers 2-10

    Students 2-13

EFFECT OF PHYSICAL LAYOUT ON EXPERIMENTAL PROCEDURES 2-14

    Ventilation 2-14

    Lighting 2-15

    Ingress and Egress 2-16

    Showers and Eyewashes 2-16

SPECIAL INSTRUCTION AND PRE-EXERCISE DEMONSTRATIONS 2-17

    Better Techniques 2-18

    New Hazards 2-19

    Personal Protective Devices 2-20

IS COMMON SENSE ENOUGH? 2-21

REFERENCES 2-22

LESSON NO. 2

NOTES	INSTRUCTION

INTRODUCTION

The importance of laboratory safety has been recognized for many years in the world of work. However, safety practices and programs seem to be the exception rather than the rule in educational institutions. Safety in the school science laboratory appears to be treated informally and briefly, if at all. Few teachers have been lauded for devoting classtime to formal training in the recognition, evaluation, and control of immediate hazards to life, limb, and property in the laboratory setting.

Pervasive health hazards are neglected even more than eminent safety hazards, but this is understandable. Health hazards are usually more difficult to uncover because the effects may not show up for years. Determining that a chemical compound is injurious to your health often requires expensive longitudinal studies in epidemiology. In some cases, extrapolations to humans can be made from toxicological studies on laboratory animals. In other cases, extrapolations can be made from studies of industrial

LESSON NO.

NOTES

INSTRUCTION

exposure. In all cases, the development of health hazard data is complex and costly - the reason why it may sometimes be sketchy and speculative.

Even so, there is a substantial body of validated information available on health as well as safety in the workplace. Until more research is conducted in school settings, results aimed at the industrial environment will also provide useful guidelines for educational situations.

All members of the science education community have a professional responsibility to keep themselves and their work up-to-date in this vital area. The remainder of this lesson addresses some critical needs of textbook authors and publishers, as well as science supervisors and teachers. Teacher educators will note where gaps in their curricula also need to be filled.

Appendices B and C

Appendix E contains a Walk-Thru Survey which also may be used to assess needs.

Resources are included in Appendices B and C, to be distributed to trainees as part of the workshop lessons.

LESSON NO. 2

NOTES	INSTRUCTION
	EVERYBODY HAS SOME WORK TO DO Authors and Publishers Impetus for the development and implementation of effective laboratory safety and health programs must come, in part, from authors and publishers of science textbooks. Information on the type of related material now available from this source was obtained by examining a selection of 18 high school science textbooks. Six of the books were chemistry texts, six were biology texts, three were physics texts, and three were general science texts. Not one of these 18 textbooks contained any information about health and safety problems in science laboratories. Some teacher's editions and all of the laboratory manuals for the textbook did include some basic information on laboratory safety. However, these presentations usually occupied only one page or less. Both teacher's editions and laboratory manuals almost entirely neglected the area of laboratory health hazards. There was almost no information on the toxicity of

LESSON	NO. 2
NOTES	**INSTRUCTION**
	chemical compounds or the health effects of exposure to the various forms of radiation. Some of the laboratory manuals included specific precautions with each experiment. A typical example was a caution statement emphasizing the flammability of carbon disulfide. Specific wardings of this kind are highly desirable, but the practice of providing them is apparently limited to a small number of publishers. There is a tremendous need for publishers to produce textual material on school science safety and health. Basic self-protection should be learned by students as early as possible for use during the rest of their lives. Many practices for school laboratory safety are applicable in all areas of scientific study and work. Learning about experimental principles should not be restricted to the study of cause and effect in laboratory manipulations. Even in so-called "codebook chemistry", hazards presented by the experiment itself, or by one or more of the components of the experiment, should be considered in the experimental design. To

ignore this aspect of lab work is to erode the purpose of such experience for the science student.

Authors and publishers should recognize their duty to provide technically accurate material that promotes safety and health. This obligation is a legal, moral, and social responsibility. If an author or publisher provides false or misleading information, or fails to provide proper precautionary statements, each might be legally liable for such actions.

Some authors and publishers appear to have good intentions, but lack technical expertise about laboratory safety and health problems. One of the laboratory manuals examined contained three experiments using iodine (I_2). The following caution statements appeared in a sequence of eight pages.

Caution No. 1: Do not handle I_2 with your fingers. If any gets on your skin, wash the affected area with soap and water. Then report to your teacher.

Caution No. 2: Iodine is poisonous. Be

NOTES	INSTRUCTION
	very careful not to inhale its vapors. Also, avoid any contact of the solid with your skin.
	Caution No. 3: Iodine is toxic. Do not handle it with your fingers. (If you do, it will stain your skin.) Do not breathe its vaports.
Peterson (1976)	The manual did not warn that iodine vapor, even in low concentrations, is extremely irritating to the respiratory tract, eyes, and, to a lesser extent, the skin. Exposure to atmospheric concentrations above 0.1 parts per million (ppm) causes increasingly severe eye irritation along with irritation of the respiratory tract. Iodine in the crystalline form or in strong solutions is a severe skin irritant. It is not easily removed from the skin, and, after contact, tends to penetrate and cause continuing injury. Ulcers may develop from iodine remaining fixed to the skin. Iodine burns resemble thermal burns except that the burned area is stained brown. Iodine is also a powerful oxidizing agent. An explosion is possible if iodine comes in contact with materials such as acetylene or ammonia.

NOTES

INSTRUCTION

Ingestion of as little as 2 grams of iodine can be fatal. Individuals with thyroid disorders should not be exposed to iodine in any amount.

The previous description of the actual effects of iodine clearly shows that iodine is a serious health and safety hazards. Students and teachers deserve more warning than the three "cautions" provide.

Caution No. 3 is actually dangerous, implying that the only hazard presented by iodine is stained skin. Caution No. 1 implies that iodine is a skin hazard of some type, but does not provide any information about the mode of action or the health effects. Caution No. 2 neglects to mention the consequences of inhaling the vapor.

None of the three caution statements mentions the oxidizing properties of iodine which may cause an explosion. No emergency treatment is given beyond washing the affected skin area.

All of the potential effects of exposure to a hazardous material should be included in a warning statement. Following is a caution statement which could be used in all three lessons:

LESSON	NO. 2
NOTES	**INSTRUCTION**
	Caution: Do not touch solid iodine with your bare skin. Do not inhale iodine vapors. The solid can cause severe skin burns and contact may result in skin ulcers. The vapor is highly irritating to the nose, throat, and lungs. Conduct all laboratory operations that may result in the generation of iodine vapor in the fume hood. Wear gloves and use spatulas or tongs when handling the solid. If any iodine gets on your skin, wash off immediately with large quantities of water, and then inform your teacher. Iodine is a strong oxidizing agent! Do not put the solid in contact with any organic solid, liquid, gas, or vapor. Proper warnings require more effort and space, however, they should be included in textbooks and manuals to promote safe and healthful learning conditions in the school science laboratory. Teachers Preparation is an important element of lab safety. Teachers should perform and "debug" all class experiments in advance. To protect them-

NOTES	INSTRUCTION
	selves in the process, it is obviously desirable to know as much as possible about potential safety and health hazards before the "hands-on" stage. It might be wise to develop standard procedures for preliminary library research along these lines. The best warning about using only textbooks for guidance may be "proceed at your own risk". Keep in mind the normal lag between the discovery and application of knowledge in any field. Then think about the lengthy process of planning, developing, and producing instructional materials. Add to this the time required to review, select, and purchase new textbooks for your classes. If you assume a total minimum lag of 5 to 10 years, it should be clear why textbooks alone are not up-to-date sources of information about laboratory hazards. Authors and publishers of science textbooks also seem to suffer from the general human tendency to continue with traditional activities long after the original need has expired. Some of the "classic" experiments in

LESSON NO. 2

NOTES	INSTRUCTION
See Appendix B.	school science were developed to demonstrate concepts that were not considered to be hazardous at the time. The use of mecury to coat coins is an example. Unfortunately, in the process of modernizing the package, makers and sellers of science texts have not always taken a critical look at the safety and health aspects of the product. The solution to this problem is that old consumer adage "buyer beware". In other words, teachers, don't assume that an experiment is safe just because it has been around since you were in high school. Check it out against reliable sources of hazard information.
	For some unexplained reason, high school chemistry books often include the use of sodium and phosphorus in laboratory experiments. A manual in current use suggests a teacher demonstration involving the dissolution of red and white phosphorus in carbon disulfide. The text contains warnings about the poisonous nature of white phosphorus and the fact that it can cause serious skin burns. However, nothing

NOTES	INSTRUCTION
	is said about the danger of mixing either form of phosphorus with oxidizing materials or the health hazard presented by carbon disulfide. There is a warning about the fire hazard of carbon disulfide. There seems to be no justification for such a demonstration by teachers or students. Teachers should have access to much more information than the text provides to insure the safety and health of all concerned. Students Many problems can arise when students do not understand what they are doing. What they do not know may affect your life as well as theirs. Students must be carefully taught to realize the seriousness of safety and health hazards that accompany high school science laboratory work. Teacher educators can help here. Probably no other thread will tie a student's science laboratory work together as well as proper instruction in safety and health. Knowledge, skills, and attitudes acquired in this area will be useful as long as the student works in science - from high school and college through professional work in biological and

NOTES	INSTRUCTION
	and physical science, engineering, medicine, nursing, and other applied fields.

EFFECT OF PHYSICAL LAYOUT ON EXPERIMENTAL PROCEDURES

The resources available in a science laboratory should control the type of work that is performed. Hazardous materials should not be used where facilities and space increase rather than decrease the chances of injury and illness.

Ventilation

Experimental science work may require the use of volatile hazardous chemical reagents or result in the generation of a toxic or flammable gas or vapor. Such laboratory activity should be done in a properly ventilated area. Fume hoods should be used routinely for chemical experimentation even if textbooks do not stress the importance of proper ventilation. For example, one text gives directions on how to make chlorine water with chlorine gas. No mention is made of the precautions that should be taken with respect to adequate ventilation.

NOTES	INSTRUCTION
	Chlorine gas is an extremely debilitating chemical. It is fast-acting, with long-term, harmful health effects on anyone unfortunate enough to be exposed to it. Proper ventilation should be an integral part of every laboratory operation. Ventilation requirements for science laboratories are well-documented. Details are presented in the lesson on ventilation. Lighting Proper lighting is another important part of a laboratory safety and health program. Inadequate lighting can be a direct cause of accidents. Other problems which may be caused by poor lighting include eye discomfort and fatigue, headaches, and nausea. It is unlikely that lighting in the science lab would be entirely responsible for any of these problems. However, poor lighting throughout a school may have a debilitating effect on students and teachers. Continuous exposure to poor lighting may result in laboratory accidents. Lighting is discussed further in the lesson on laboratory hardware.

LESSON	NO. 2
NOTES	**INSTRUCTION**

Ingress and Egress

Every school science laboratory should have at least two exits. This requirement is included in most building and fire codes. One exit should be usable even if the other is obstructed or obscured by fire or smoke. Doors must not be blocked by desks or laboratory benches. Flammable material should not be stored next to an exit. Work areas should be designed so that all students have ready access to an exit at all times.

Laboratory plans now and in the future must allow for the needs of handicapped students or teachers. Special requirements of these people must also be considered in assigning work locations. They should be located as close to a usable exit as possible. For example, a student in a wheelchair must not be placed near an exit that requires the use of a fire escape.

Showers and Eyewashes

Safety showers and eyewash facilities are necessary for the safe operation of every

NOTES	INSTRUCTION
	science laboratory. No hands-on activity should begin until provision has been made for rapid access to such equipment. The location of these particular safety devices is often controlled by the availability of water and drain lines. Laboratory work areas must be designed accordingly. SPECIAL INSTRUCTION AND PRE-EXERCISE DEMONSTRATIONS Nearly all laboratory manuals for school science include classroom demonstrations to be conducted by the teacher. Directions and background information may be sketchy, particularly where safety and health considerations are concerned. Supervisors and teachers will probably want to work together in determining the educational value of these demonstrations versus the hazards they may present to both teacher and student. This is another area for teacher educators to tackle.

Better Techniques

Lab manuals may suggest demonstrations that are acknowledged or known to be dangerous. These demonstrations should be substituted with audio-visual aids or other teaching /learning methods or materials that present little or no hazards.

A demonstration suggested by one textbook is designed to show that two chemical compounds may have the same formula but different structures and physical properties.

The recommended compounds are ethyl alcohol and methyl ether. However, the book also suggests that ethyl ether can be substituted for methyl ether.

Ethyl ether is widely recognized as a laboratory safety hazard. It forms explosive mixtures with air over a broad range of concentration (1.9% - 36%). It has low ignition temperature (356°F). Ethyl ether also forms unstable peroxides which can explode spontaneously or upon heating. These peroxides can form if the ether is allowed to stand too long before disposal or if is stored in sunlight.

NOTES	INSTRUCTION
	Ethyl ether clearly does not belong in a school science laboratory! The demonstration would be effective if two materials like ethyl acetate and butyric acid were used. They have the same formula - $C_4H_8O_2$ - but vastly different chemical and physical properties and neigher approaches the safety hazard of ethyl ether! New Hazards Hazards become known from the use of new materials or from new information about commonly used materials. The development of new information about hazards is proceeding at a rapid pace. Extensive research is being done in air pollution, industrial hygiene, medicine and related fields such as toxicology. An example of new information about a widely used material is the discovery of the cardinogenic nature of vinly chloride. Another well-known material which has recently been indicated as a carcinogen is benzene, an organic solvent found in most school science laboratories. The use of these substances may be

LESSON	NO. 2
NOTES	**INSTRUCTION**

regulated in some schools by Federal or State OSHA regulations. Supervisors should brief teachers on regulations that are applicable. However, teachers are directly responsible for either removing these materials or controlling their use in the science classroom and laboratory.

Personal Protective Devices

The proper use of personal protective devices is essential in all safety and health programs. Teacher usage is crucial to the development of proper usage by students. If a teacher refuses to wear personal protective equipment al all tims in the laboratory, students can hardly be expected to behave differently.

In many states, the law requires that everybody in science laboratory classes must wear some type of acceptable eye protector. Teachers may determine which eye protection device is to be used in any given situation, and then make sure that device is available to everyone.

NOTES	INSTRUCTION
	Personal protective devices include safety glasses, goggles, and face shields; lab coats and gloves; hearing protectors; respirators and filter masks; protective creams and lotions. Each product has a particular use and every laboratory teacher should be familiar with its proper application. IS COMMON SENSE ENOUGH? Many of the accidents that happen in school laboratories could probably be prevented by the application of liberal doses of common sense. Some accidents with safety implications involve everyday problems that just happen to occur in a school science laboratory. For example, the student who trips over his own feet or breaks a glass beaker and cuts himself is not the victim of hazards confined to science laboratories. Some hazards, however, are endemic to science laboratories and are unlikely to be encountered anywhere else. The potential for severe damage to both people and property is so great that safety and health problems cannot

LESSON	NO. 2
NOTES	**INSTRUCTION**
	be left to the common sense of either teachers or students. A safety program will not be effective unless teachers and students receive extensive formal instruction in protective practices. The area of safety and health merits as much or more attention than any other part of the science curriculum.

REFERENCES

Peterson, J.E.. "Iodine and Compounds", Encyclopedia of Occupational Safety and Health, Vol. 1. McGraw-Hill Book Company, New York (1976)

Safety in Academic Chemistry Laboratories. American Chemical Society, Committee on Chemical Safety, Washington, D.C. (January 1976).

LEGAL ASPECTS OF LABORATORY SAFETY

No. 3

METHODS Lecture and Discussion

LENGTH 15 minutes

PURPOSE Provide information about the potential liability arising from injury-producing accidents in laboratories under teacher control.

OBJECTIVES

Enable the teacher to ...

1) Know and be able to identify the types of potential legal liability which can be incurred through negligent behavior

2) Know, understand and be able to apply the 3 responsibilities: instruction, supervision, and maintenance

3) Prepare a personal plan for protection from the consequences of legal liability for injury-producing accidents in the laboratory.

SPECIAL TERMS

Foreseeability
Liability
Master-servant relationship
Negligent act
Reasonable man
Sovereign immunity doctrine
Tort law

INSTRUCTOR MATERIALS

Lesson Plan
Chalkboard, Chalk, Eraser
Project (35mm) and Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 3-3

NEGLIGENCE IN TORT LAW 3-4

What Constitutes a Negligent Act? 3-6

Cases in Which the Instructor Conduct Was Adjudged to be Questionable 3-7

Cases in Which the Instructor Has Been Adjudged Not Liable . 3-13

Avoiding Negligent Acts 3-18

Liability Insurance 3-20

Employer-Employee Relationship 3-21

Laboratory Procedures 3-22

REFERENCES 3-24

LESSON NO. 3

NOTES	INSTRUCTION
	INTRODUCTION
Introduction	The classroom teacher can be placed in the unenviable position of being the only party amenable to suit among all potentially liable parties - the state, the school district, the school board, the school administration and the school teacher. Teachers can incur legal liability in a number of ways; however, only one is of interest here and that is negligent behavior.
Basic duties of classroom teachers	The classroom teacher has two basic duties which are related to the legal concept of negligence. These are the duty of instruction and the duty of supervision.

NOTES	INSTRUCTION
	NEGLIGENCE IN TORT LAW
Concept of negligence in tort law Ripps (1975)	Negligence, in the eyes of the law, may be defined as conduct that falls below a standard of care established by law to protect others against an unreasonable risk of harm. If the standard of care has not been specifically established by statute, the actions or inactions of an individual will be measured against what a hypothetical, reasonably prudent individual would have done under the same circumstances. Obviously there can be legitimate and complex questions regarding the course of action which a prudent man would take under a given set of circumstances. Later in the presentation examples of legal thinking on what the prudent man is will be given.
Concept of foreseeability	One important aspect of the conduct of the reasonable man is anticipation. A reasonable man is expected to be aware of the foibles of human nature and be able to anticipate where difficulties might arise. Thus, a pedestrian may not step blindly in front of a moving vehicle expecting the driver to stop, and a

LESSON	NO. 3
NOTES	**INSTRUCTION**
	teacher may not direct a student to perform a dangerous experiment without giving adequate instruction and supervision. The reasonable teacher must be able to anticipate the common ordinary events and, in some cases, even the extraordinary.

LESSON NO. 3

NOTES	INSTRUCTION
Negligent acts	What Constitutes a Negligent Act? The determination of negligence often presents some difficulty. In the prior section the concept of a reasonable man was discussed. In this section and the following sections, the negligent acts of teachers will be considered.
Duties of teachers	Earlier it was mentioned that teachers have two basic duties - the duty of instruction and the duty of supervision. There is also a third duty that pertains to science teachers which is the proper maintenance and upkeep of all equipment and supplies used by the students.
Burdens of teachers	Science teachers have responsibility of all three duties. Students in laboratory classes should not be allowed to engage in an activity without first receiving complete instructions from the teacher. The teachers should include in such instructions an explanation of the basic procedure involved, some suggestions on conduct while performing the activity, and the identification and clarification of any risks involved.

Cases in Which the Instructor Conduct Was Adjudged to be Questionable

In the following cases, the laboratory teacher was held to be guilty of negligent conduct or his or her conduct was held to be a proper question for jury consideration.

Mastrangelo v. West Side Union High School (1975)

In Mastrangelo v. West Side Union High School, a 16-year old high school student was seriously injured in the school chemistry laborabory when a chemical mixture exploded in his hands. The student was pulverizing a mixture of charcoal, sulfur and potassium chlorate with an iron mortar and pestle. The student had substituted potassium chlorate for the specified potassium nitrate. The student had received no instruction in the danger of substitution in this kind of experiment. The student filed suit alleging negligence on the part of the instructor. The court stated that it was not unreasonable to assume that the duty of a teacher of chemistry, exercising ordinary care, includes instructing the students regarding the selection, mingling and use of ingredients with which dangerous experiments are to be

NOTES	INSTRUCTION
	accomplished rather than to merely hand them a textbook with general directions to follow the text.
Reagh v. San Francisco Unified School District (1953)	In Reagh et al. v. San Francisco Unified School District, a high school student brought an action against the school district for injuries he received in the spontaneous explosion of some chemical reagents. The student was enrolled in an R.O.T.C. program at the school. The student had asked his chemistry teacher for instructions on making smoke bombs to be used in the R.O.T.C. maneuvers. The student asked the instructor if it would be all right to add potassium chlorate and sugar to red phosphorus to make the smoke bomb and the instructor said yes. The student put quantities of the three chemicals into the same container. The container exploded severely injuring the student. The court stated that the teacher had never instructed the class in the danger of combining potassium chlorate with either sugar or red phosphorus although the teacher knew they might explode. The court held that the question of whether the school district and its employee,

NOTES	INSTRUCTION
Jay v. Walla Walla College (1959)	the teacher, were negligent in allowing the student access to the chemical reagents without proper instructions was a legitimate question for the jury. In Jay v. Walla Walla College, a college student was seriously injured when an explosion occurred as he was trying to fight a laboratory fire. The student was working on an authorized experiment when he heard an explosion across the hall. He ran across the hall with a fire extinguisher and was injured when a more serious explosion occurred. The initial explosion occurred in the midst of an experiment involving ethyl ether and which was conducted by two other students. There was evidence that the professor guiding the two students failed to provide the proper supervision and direction even after he had been notified of two previous minor explosions which had occurred during the course of the experiment. The court held that the question of whether the professor had provided the proper supervision for the students under his direction was a

NOTES	INSTRUCTION
	proper question for the jury to decide and the court affirmed the verdict for the student.

In Bush v. Oscoda Area Schools, a student brought suit for personal injuries against her teacher, school principal, district superintendent and the school district itself. The student was injured when a container of methanol ignited in a classroom. A mathematics classroom was being used for a physical science class due to crowded school conditions. The room contained no storage or ventilation facilities nor any of the other equipment usually associated with a science laboratory.

Open flame alcohol lamps were used in the science experiments because gas outlets were not available. Methanol was stored in bulk in an old plastic jug which was allegedly damaged and split. The jug and the lamps were kept on a counter in the rear of the room. The student alleged that some methanol had been spilled on the counter near a lighted lamp, and, as she attempted to extinguish the lamp, there was an explosion and fire which ignited her clothing and resulted in severe second and third degree

NOTES	INSTRUCTION

burns to her person.

The student claimed various acts of negligence including the following affirmative acts:

1. Leaving spilled alcohol exposed to ignition sources;
2. Failure to properly handle and store the methanol when open flame lamps would be in use proximate thereto; and
3. Keeping the methanol in a damaged container

The plaintiff also claimed the following acts of omission:

1. Failure to warn and supervise students in handling methanol around flame;
2. Failure to train students and school personnel in the use of the fire alarm system and fire extinguishers; and
3. Failure to have the fire alarm equipment in working order.

The court held that the school district was immune from liability under the government immunity doctrine and that the superintendent was not personally negligent in any way. As to the teacher, the court held that her conduct was of such a nature as to constitute a proper question for the jury. As to the principal, the court held that he was not responsible for the acts of the teacher, but, as he was responsible for curriculum and class scheduling, he should have known of the dangers inherent in using the mathematics classroom as a physical science laboratory, and, consequently, his conduct is also a proper question for the jury.

The four cases described above give examples of real teaching situations and incidents. Examples of this nature are more illustrative and forceful than a list of do's and don'ts. These four cases can be used by every teacher as a yardstick against which their own behavior can be measured.

LESSON NO. 3

NOTES

INSTRUCTION

Cases in Which the Instructor Has Been Adjudged Not Liable

Moore v. Minor Order Conventuals (1959)

Teachers have not always been found liable in laboratory accidents. In Moore v. Order Minor Conventuals, a student was adjudged guilty of contributory negligence after he was severely injured in a chemical explosion. The student, along with fellow students, had received permission from the teacher to enter a laboratory to set up equipment for an experiment to be conducted later. While in the laboratory, the student attempted to make a batch of gunpowder using a formula of his own. He mixed potassium nitrate, sulfur, manganese dioxide, and phosphorus together. An explosion occurred and he was seriously injured. The student claimed negligence on the part of the school and teacher because no instructions had been given to him with respect to safety in the laboratory and no warnings as to the dangers involved in mixing chemicals.

The court held that the student's injuries were the result of his own imprudent acts, and no award could be granted to him.

LESSON NO. 3

NOTES	INSTRUCTION
	In Wilhelm v. Board of Education, two 13 year-old students were working on science projects, with the approval of the teacher, in a laboratory with the door closed. After 10 minutes, the two students began to play with some chemicals in glass bottles which were on a laboratory shelf. The students knew that the chemicals were dangerous. While they were mixing and grinding the chemicals, the mixture flared up seriously injuring the plaintiff. The court held that the plaintiff was guilty of contributory negligence as a matter of law and disallowed his claim. In Bottorf v. Waltz, a student brought legal action against a teacher for injuries sustained in an art class. The student was severely burned when a container of hot wax fell on his back. The instructor had decided to teach candlemaking to his class. The school provided hot plates, some molds, wicks, melting pots and hot pads. The hot plates had no thermostatic control. When the project began, double boilers, with the wax in the top container and water in

LESSON NO. 3

NOTES	INSTRUCTION

the bottom one were used to heat the wax. The necessity of getting the experiment completed within a 45-minute class period, however, impelled the change to a faster procedure, and so, the students were permitted to place the melting pots directly on the hot plates. However the teacher instructed the students to pour the wax into the mold as soon as it was liquid. The teacher instructed the students as to the dangers involved in dealing with hot wax, the precautions to be taken, and the first-aid procedures to be followed in the event of a burn.

The candle-making apparatus was set up on heavy work tables along one wall. During each class period, one candle maker and one helper were permitted to work at each of the three stations while the rest of the class remained in their seats and worked on other projects.

The plaintiff was a helper at one of the stations when the accident occurred. The teacher noticed that the two students had spilled some hot wax on the floor while pouring wax into a mold. He instructed the two students to clean the wax from the floor before it hardened. The teacher asked another student to take them a screwdriver to one scraping the wax off the floor. As the third student turned to leave the station she bumped the table causing the mold to tip over and dump hot wax on the back of the plaintiff who was still cleaning the floor.

The plaintiff claimed negligent supervision on the part of the teacher. The court held that even though the conduct of the teacher contained some questionable aspects - for example, his allowing a potato chip can to be used as a mold (regular molds are weighted at the bottom), and his decision to use hot plates without thermostats - every risk created by the teacher's actions was counterbalanced by pre[illegible]tions that a jury could reasonably decide to be sufficient. The teacher's actions were judged not to constitute negligence at law.

The cases discussed give an indication of how courts view certain situations. However, the law is constantly being changed, altered, or modified to deal with changing social patterns.

LESSON	NO. 3
NOTES	INSTRUCTION
	The current trend in negligence cases of this nature is in favor of the plaintiffs and against the defendants.

LESSON NO. 3

NOTES	INSTRUCTION
	Avoiding Negligent Acts
Avoidance of negligent acts	Teaching personnel must be constantly aware of their duties as viewed by the courts. No student actions should be permitted without detailed instruction and supervision. The following list of guidelines is intended to aid teachers in carrying out their duties and minimize their chances of becoming involved in any future legal proceedings:
List of guidelines	(1) Teachers are expected to protect the health, welfare, and safety of their students. (2) Teachers must recognize that they are expected to foresee the reasonable consequences of their inactions. (3) Teachers must carefully instruct their classes and must give careful directions before allowing students to attempt independent projects. (4) All activities must be carefully planned. (5) Teachers must be careful to relate any risks inherent in a particular laboratory experiment to students prior to their engagement

NOTES	INSTRUCTION
	in that activity. (6) Teachers should create an environment in which appropriate laboratory behavior is maintained. (7) Teachers should report all hazardous conditions to supervisory personnel immediately and insist that the conditions be corrected immediately. (8) Teachers should keep adequate records covering all aspects of the laboratory operations. (9) The teacher's presence in the laboratory is recommended to assure adequate safety supervision. (10) Teachers should be aware of local laws and regulations that relate to laboratory activities in science.

LESSON NO. 3

NOTES	INSTRUCTION
Liability insurance	Liability Insurance Liability insurance covering negligent acts is available to teachers. The effect of carrying liability insurance is twofold. On the one hand, it helps in protecting the teacher against financial loss resulting from negligent behavior, but, on the other hand, it makes the teachers more amenable to lawsuits. Because of the existence of insurance, more and more lawsuits involving negligent conduct by teachers on the playground, in the gymnasium and in the classroom are being filed. Liability insurance is a protection, but it should be regarded as secondary to the teacher's conduct.

LESSON NO. 3

NOTES	INSTRUCTION
	Employer-Employee Relationship
Employer-employee relationship Doctrine of sovereign immunity	In general, public school districts cannot be sued for torts committed by the district itself or by its agents or employees. This principle is based on the sovereign immunity doctrine which held that any governmental operation could do no wrong and therefore could not be sued without its consent.
Baird v. Hosmer (1976) Bush v. Oscoda (1976) Master-servant relationship	This doctrine does not extend to teachers as employees of public school districts. Teachers are, in the eyes of the law, fully liable for the consequences of job-related negligence. The legal rationale for holding that there is no true master-servant relationship between a school district and its employees is not particularly relevant to the teacher. What is relevant is that he or she may wind up bearing the brunt of any legal action.
Private schools	Teachers in private schools are fully liable for their negligent acts, but in this case their employer may also be liable.

LESSON NO. 3

NOTES	INSTRUCTION
Proper laboratory procedures	Laboratory Procedures Earlier it was noted that the classroom instructor has two basic duties - instruction and supervision - and a third duty, related to the other two, which involves the proper maintenance of facilities and equipment.
Student behavior	One aspect of proper supervision is the control of student behavior in the laboratory. Teachers have frequently been held liable for injuries occurring as a result of the misbehavior of one or more students. It is imperative that the teacher stress proper conduct in the laboratory. The nature of a science laboratory is such that no student misbehavior of any type should be tolerated.
Teacher behavior	One of the most important aspects of proper instruction and supervision is by teacher example. Instructors who show little or no respect for proper laboratory procedures are in no position to complain when the students imitate their bad example. Therefore it is incumbent upon each individual science teacher to be informed of the latest developments in safe laboratory operation

NOTES	INSTRUCTION
	and to institute them in his/her own laboratory whenever necessary. Instructors can be held liable for a failure to act as well as acting improperly. If an instructor fails to institute safety and health practices that are routine in other education science laboratories, he/she may be risking serious personal liability.
Equipment maintenance	Another potential source of trouble for the school science teacher is the equipment contained in most science laboratories. While the equipment may be the ultimate responsibility of the school and school district, the responsibility for maintenance falls upon the teacher. An injury occurring to a student as a result of poorly maintained equipment can have serious financial and occupational consequences to the affected instructor. The teacher can minimize this liability by keeping the proper maintenance records and filing the proper reports with the responsible administrative officers. The teacher's greatest defense is prior notice of equipment defects to the school administration. It is further recommended that this notice be made in writing, with file copies retained.

NOTES	INSTRUCTION

REFERENCES

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Ripps, S.R.: The Tort Liability of the Classroom Teacher, Akron Law Review 9:19 (1975).

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STUDENT INVOLVEMENT IN SAFETY PROGRAMS NO. 4

METHODS Lecture and Discussion **LENGTH** 30 minutes

PURPOSE Provide suggestions for implementing an effective safety program in the school science laboratory.

OBJECTIVES Enable the trainee to ...

1) Identify ways and means of motivating student interest in laboratory safety.

2) Select appropriate opportunities for the active participation of all students in laboratory safety.

3) Create a meaningful safety role model for science students in the laboratory.

SPECIAL TERMS

Epidemiologist
Industrial hygienist
Job-related hazard
Occupational health nurse
Occupational safety and health
Safety contract
Safety enforcement
Safety engineer
Safety foreman
Safety rule

INSTRUCTOR MATERIALS

Lesson Plan
Slides
Chalkboard, Chalk, Eraser
Projector (35mm), Screen

TRAINEE MATERIALS Note-taking

CONTENTS

INTRODUCTION 4-3

  Safety Programs 4-4

SAFETY AND HEALTH IN THE JOB WORLD 4-4

  Student Activities 4-5

  Resources 4-6

SAFETY AND HEALTH CAREERS 4-7

  Student Activities 4-8

  Resources 4-8

LAB SAFETY ACTIVITIES 4-9

  Safety Committees 4-9

  Safety Contracts 4-10

  Safety Rules 4-10

  Safety Orientation 4-11

  Safety Foremen 4-12

  Safety Campaigns 4-12

  Safety and Health Research 4-13

GETTING STARTED 4-14

REFERENCES 4-16

EXHIBITS

4-1. Profile of a Safety Professional 4-17

4-2. Sample Student Safety Contract 4-18

4-3. Sample Laboratory Safety Rules 4-19

4-4. Some Current Student Problems 4-20

LESSON Student Involvement in Safety Programs NO. 4

NOTES	INSTRUCTION

INTRODUCTION

Learning to solve problems "hands-on" by experimental methods is important to the intellectual development of every youngster in a scientific civilization. This kind of science education is perhaps one of the best ways to counteract the resurgent interest in mysticism and psychic beliefs about which a well-known space scientist has remarked:

Sagan (1977), pp. 237-8

> " ... their widespread acceptance betokens a lack of intellectual rigor; an absence of skepticism, a need to replace experiments by desires.

Learning to use experimental methods in safe and healthy ways is also important to the development of science students, to their well-being, and perhaps even to their survival over a normal life expectancy.

There is much more to science safety than rules and regulations for the preservation of school life, limb, and property. Other sides of the picture may provide some of the motivation that is essential to the success of laboratory safety programs.

LESSON Student Involvement in Safety Programs NO. 4

NOTES	INSTRUCTION
	Safety Programs The foundation for all safety activity should be a formal program with the official stamp of approval by school administrators and the active support of parents. Policies and guidelines may come "from the top", but teachers have to assume the responsibility for making school safety work. Instructional objectives for safety should comprise the framework of all activity, with teachers providing the role models. Exemplary leadership is critical. Students will develop good work practices only if teachers set the pace by actions as well as words. SAFETY AND HEALTH IN THE JOB WORLD Occupational safety and health is a big and possibly new world for science teachers. It is so dynamic that full-time professionals can barely stay on top of the changes. However, there is room for everyone to contribute as well as benefit. Teachers and students who like to keep up with what's going on, and be where the action

NOTES

INSTRUCTION

is, will find that lab safety is only the tip of a very rewarding iceberg.

Sooner or later, most science students will join the labor force as paid workers. Some may be laboratory employees. Others may be involved directly or indirectly with the manufacture, utilization, or handling of hazardous materials. Each will be exposed to safety and health hazards of some kind on the job, especially chemicals. This is a fact of everyday life in our technological society.

All levels of white and blue collar workers are affected by their job conditions. Paychecks, along with a full and productive life, may depend on the knowledge and skill required to cope with job safety and health hazards. In other words, it's worth the effort for students to find out what they might be up against and how to deal with it.

Student Activities

Research and reports about potential work hazards may help youngsters make occupational choices, as well as treat lab safety as job

LESSON Student Involvement in Safety Programs NO 4

NOTES	INSTRUCTION
	training for future employment. Reading and talking about the job world can be used to emphasize the importance of school lab safety.
See Appendices B and C.	Resources Publications for career education generally are not very specific about job-related hazards, except for the spectacular and obvious risks. Information directed towards workers and small businessmen may be more suitable.
Job Safety & Health	Sources include government agencies and other organizations concerned with safety and health. For example, OSHA publishes a monthly magazine that includes articles on many kinds of work. NIOSH issues a series of health and safety guides for various businesses and industries. Professional societies, trade associations, and unions may also be helpful.
OSH Act of 1970 and 29 CFR 1910	Some students may wish to review legal documents on occupational safety and health. Others may want to report on popular books and advocacy literature. Science teachers should be familiar with at least classroom regulations.

NOTES	INSTRUCTION
	However, discussion of this material may be better suited to social studies.
	SAFETY AND HEALTH CAREERS
	Students often find their career niches in secondary school science laboratories. Those who want to pursue further study in related disciplines may be interested in occupational safety and health careers. The field is interdisciplinary, with a very wide range of specializations rooted in the biological, chemical, and physical sciences, plus engineering, law, and medicine.
	Among the men and women working in occupational safety and health are epidemiologists, toxicologists, health physicists, all kinds of engineers, inspectors and investigators, nurses and physicians.
	There are also roles for behavioral scientists, economists, managers, statisticians, and specialists in communications, personnel administration, and education or training.
	The generalists or overall professionals in the field are called industrial hygienists or safety engineers.

LESSON Student Involvement in Safety Programs NO. 4

NOTES	INSTRUCTION
	Job opportunities are numerous and academic programs are increasing in quantity and quality.
	Student Activities
Exhibit 4-1	Interested students may get assistance from career counselors in obtaining pertinent information. Another way is to do some individual investigation about occupational safety and health professionals, what they do, and how this relates to safety in the school science laboratory.
See Appendices B and C.	Resources
	Professional societies are usually good sources of career information. Students can begin with the following: American Association of Industrial Nurses American Industrial Hygiene Association American Society for Safety Engineers
	Government agencies like NIOSH and OSHA also publish some career information.
	Librarians should be able to help students get the right addresses.

LESSON Student Involvement in Safety Programs NO. 4

NOTES

INSTRUCTION

LAB SAFETY ACTIVITIES

Given the implications of science education for the job world, students may respond favorably to a "worker" approach to safety in the school laboratory. Some teachers may find it difficult to think of students as workers and themselves as job supervisors, but the parallel roles are obvious and worth exploring. Here is where the extensive experience and literature of safety in industry could be very useful.

Safety Committees

This is a widely used means of getting management and labor together on safety matters. In science education, teachers and student representatives (perhaps elected by their peers) might be able to work together with administrators in developing safety guidelines.

Consultation with available safety and health professionals is strongly recommended. Parental representation may be desirable. Sponsorship by local business and industry might be considered.

Teachers may be skeptical of "outside

NOTES | INSTRUCTION

meddling" in classroom affairs. However, using resources in the community could make their safety work easier and more successful.

Exhibit 4-2

Safety Contracts

The National Science Teachers Association suggests that students be requested to sign a "contract" that specifies acceptable behavior in a school laboratory situation. Such a contract should include basic rules to follow, plus a statement indicating that the signee agrees to abide by these rules and any additional safety directions provided by the teacher or school administration.

The primary purpose of the contract is to make the student aware of his/her own responsibility for laboratory safety. Students should also realize the implications of improper behavior. For example, courts have ruled that students can be just as guilty of negligence as teachers in laboratory accidents.

Exhibit 4-3

Safety Rules

Working alone or with a safety committee, every science teacher must prepare and distribute

LESSON Student Involvement in Safety Programs NO. 4

NOTES

INSTRUCTION

to each student a written set of rules for laboratory activities. These "do's and don'ts" should be quite specific, as contrasted to the more general statements in a safety contract. The list should be long enough to cover all basic requirements for lab safety. Each item should be worded as clearly and concisely as possible.

People in general and students in particular tend to resist and ignore rules, especially when these are stated negatively. However, there are situations for which authoritative words like "must, never, and do not" are essential to personal safety. Teachers and students can learn to live with this terminology, in both the literal and figurative sense.

Safety Orientation

Before any "hands-on" activity begins in a science course, teachers should conduct a thorough safety orientation for all students. Acceptable behavior and enforcement procedures should be reviewed in detail. Anyone who misses any part of the orientation should be briefed before proceeding to actual lab work.

LESSON Student Involvement in Safety Programs NO. 4

NOTES | INSTRUCTION

Arrangements should also be made by teachers and administrators for the orientation of potential substitute teachers, student teachers, and anyone else who might take over or participate in science classes.

Safety Foremen

Borrowing again from industry, the idea of student assistance as safety foremen seems to have merit. This job could be rotated among students selected on whatever basis is most appropriate.

Teachers will find it difficult, if not impossible, to do all of the safety work in school labs without help. Trained and reliable students should be able to assist with routine activities and alert teachers to special problems.

Safety Campaigns

Many support activities are used in industry to promote and implement safety programs. Similar activities for school science safety may be limited by priorities and resources. However, teachers and students are usually

NOTES	INSTRUCTION

"masters" of creativity and resourcefulness in planning and conducting campaigns. Just to mention a few related projects, there might be posters, signs, flyers, suggestion boxes, competitions, awards, and media coverage inside or outside the school system.

Safety and Health Research

Anybody who has been to graduate school knows that much of the teachers' library research is done via student papers and the legwork of graduate assistants. This precedent should give secondary school science teachers a few ideas about how to help themselves as well as their students in matters of lab safety and health.

Of course, there is generally a difference in level of maturity, as well as availability of resources. However, college-bound and particularly honor students in advanced science courses in metropolitan areas can do wonders with literature searches.

Safety and health projects must not be confined to this group, however. Commercial students may have more interest and better skills for work such as labeling and inventories. Vocational students may know more than some science teachers about ventilation and other physical aspects of the laboratory.

A very practical and worthwhile project for all science classes is a safety manual to which _each_ student can make a useful contribution according to his/her capabilities, interests, and needs. Such a manual might include hazard information on laboratory materials, illustrations of protective equipment and directions for using it, cartoons and blurbs for laboratory practices, news stories about occupational safety and health, sources of information, etc. Both teacher and student contributions might be published as a safety handbook with "yearbook" supplements by new classes.

GETTING STARTED

This in-service training program is hopefully just the beginning of every science teacher's self-improvement plan towards a safe and healthy workplace for all school laboratory participants.

LESSON Student Involvement in Safety Programs NO. 4

NOTES	INSTRUCTION
	There is much to learn - new knowledge, skills, and attitudes for teachers, as well as students.
Exhibit 4-4	Maybe the best way to get started is to "find yourself" among the student types you know so well and then plan your own learning activities accordingly.

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Safety in Academic Chemistry Laboratories. American Chemical Society, Committee on Chemical Safety, Washington, D.C. (1976).

Sagan, Carl. The Dragons of Eden: Speculations on the Evolution of Human Intelligence. Random House, New York (1977).

Steere, N.V. (Ed.). Safety in the Chemical Laboratory. Volume Three. American Chemical Society, Division of Chemical Education, Easton, Pennsylvania (1974).

Thelen, H.A., et al. Classroom Grouping for Teachability. John Wiley & Sons, Inc., New York (1967).

Trenk, B.S. "Health Hazards in the Science Classroom", American Lung Association Bulletin (May 1977).

Note: The best way to keep up-to-date on NIOSH and OSHA material is to request a list of publications from the following:

Publications, DTS
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

Office of Information
Occupational Safety and Health Administration
U.S. Department of Labor
Washington, D.C. 20210

EXHIBIT 4-1. PROFILE OF A SAFETY PROFESSIONAL

Plans, develops, implements, and administers programs concerned with accidents, illnesses, injuries, and loss control.

Duties

1. Ensures that safety and health regulations and standards are observed.

2. Conducts safety inspections for purposes of identifying and correcting conditions having potential for injury to employees, damage to equipment or facilities, or loss of materials.

3. Reviews and approves safety aspects of new equipment, facility layout, and design.

4. Develops and approves procedures for hazardous operations. Provides specialized training and disseminates safety information necessary to maintain an interest in accident prevention and injury control.

5. Coordinates safety activities with other staff professionals, including management, industrial hygienists, nurses, physicians, and fire and security personnel.

Recommended Educational Requirements

Bachelor of Arts or Science.

Professional Development

Graduate Degree and/or Short Training Courses.

Field of Study

Chemistry, Physics, Biology, Engineering, and/or Behavioral Science.

Source: NIOSH, Careers Brochure (1977)

EXHIBIT 4-2. SAMPLE STUDENT SAFETY CONTRACT

HEADER

I will:

- Follow all instructions given by the teacher
- Protect eyes, face, hands, and body while conducting class activities
- Carry out good housekeeping practices
- Know where to get help fast
- Know the location of first aid and fire fighting equipment
- Conduct myself in a responsible manner at all times in a laboratory situation.

I, ________________________________, have read and agree to abide by the safety regulations as set forth above and also any additional printed instructions provided by the teacher and/or district. I further agree to follow all other written and verbal instructions given in class.

Date ____________________________ ________________________________

Signature

Source: National Science Teachers Association. Safety in the Secondary Science Classroom (Prepublication copy, 1977).

EXHIBIT 4-3. SAMPLE LABORATORY SAFETY RULES

1. Wear proper eye protection at all times during laboratory activity and where chemicals are stored and handled.
2. Confine or securely tie hair that reaches the shoulder. Remember that hair is extremely flammable!
3. Do not smoke, eat, drink, or chew gum in the laboratory. Dangerous chemicals may get into your mouth or lungs!
4. Do only the experiments assigned or approved by teachers. Unauthorized experiments are prohibited!
5. Never engage in horseplay or practical jokes.

EXHIBIT 4-4. SOME CURRENT STUDENT PROBLEMS

Abuse and Neglect at Home
Alcohol and Drugs
Economic Hardship
Foreign Language and Culture
Handicaps
Parenthood and Pregnancy
Terrorism
Vandalism

EYE AND FACE PROTECTION

NO. 5

METHODS Lecture and Discussion

LENGTH 45 Minutes

PURPOSE Develop understanding and appreciation of the need for adequate eye and face protection in the chemical laboratory.

OBJECTIVES Enable the teacher to ...

1) Identify hazards to eyes and face in the laboratory.
2) Determine adequate methods to evaluate or measure eye and face hazards in the laboratory.
3) Choose proper means of preventing accidents and injuries from eye and face hazards in the laboratory.

SPECIAL TERMS

- Eyewash fountain
- Eyewash station
- Face shield
- Industrial safety glasses
- Protein barrier
- Safety goggles
- Street safety glasses

INSTRUCTOR MATERIALS

- Lesson Plan
- Slides
- Chalkboard, Chalk, Eraser
- Projector (35mm) and Screen

TRAINEE MATERIALS Note-taking

CONTENTS

INTRODUCTION 5-3

EYE PROTECTION AND THE LAW 5-6

Compliance with the Law 5-7

SAFETY GOGGLES 5-9

Care and Cleaning of Goggles 5-9

FACE SHIELDS 5-11

CORRECTIVE EYEWEAR 5-12

SAFETY GLASSES 5-14

CONTACT LENSES 5-15

LASER EYE PROTECTION 5-17

EYEWASH FOUNTAINS 5-18

EYE PROTECTION POLICY 5-20

REFERENCES 5-21

EXHIBITS

EXHIBIT 5-1 Model School Eye Safety Law 5-22

EXHIBIT 5-2 States Which Have Enacted Laws

LESSON	NO. 5
NOTES	**INSTRUCTION**

INTRODUCTION

The eye is probably the most vulnerable portion of the body surface from an injury standpoint. It is also the most important link between the individual and the outside world. Every effort should be made to protect the eye.

The eye is protected from impact injuries by the bony socket in which it rests by intercepting large objects before they reach the surface of the eye. Tears provide lubrication for the eyelids and wash foreign material from the surface of the eye. The eyelids close to protect the surface of the eye from damage by small objects. The fatty tissue lining in the bony socket cushions the eye against shock.

Despite these defenses the eye is easily damaged. The eye is a complex, specialized organ which does not recover from injury as other tissue do. The eye possesses few blood vessels. Consequently, injuries are much slower to heal and may not fully recover.

Foreign bodies present the most common danger to the eye. Particles can lodge on the

LESSON	NO. 5
NOTES	INSTRUCTION
	surface of the eye where they are generally irritating or sharp objects can penetrate deep into the eye where they may cause no pain. Certain types of particles can be extremely damaging to the eye. For example, pure copper and iron particles which might penetrate the eye could result in the loss of sight because of their toxic effects on the tissue. In the laboratory, flying glass, possibly from an exploding test tube or flask, can also cause severe eye injury. The eye reacts differently to different chemical agents. If acid reaches the eye, the eye precipitates a protein barrier that reduces penetration of the acid into the eye tissue. On the other hand, caustic material in the eye is much more hazardous because the eye has no defense as with acid, and the caustic material readily penetrates into the eye tissue. Laboratory procedures that can generate liquid droplets or splashes include pouring, stirring, blending, heating, and reacting of

LESSON NO. 5

NOTES	INSTRUCTION
	chemicals. Cleaning of glassware and breaking of containers can also cause chemicals to reach the eye. Another eye hazard found in the school science laboratories is radiation. Ultraviolet, visible, and infrared radiation can all damage eye tissue if the intensity level is high enough. The increasing use of lasers in all types of laboratories is a matter for concern. The use of lasers requires special eye protection in addition to special facilities and proper techniques.

LESSON	NO. 5
NOTES	**INSTRUCTION**

EYE PROTECTION AND THE LAW

Exhibit 5-1

The National Society for the Prevention of Blindness developed a model law to require eye protection in school science laboratories and other areas where eye hazards could exist.

The Ohio law, Section 3313.643 of the Ohio Revised Code, states as follows:

> "Every student and teacher of a school, college, or other educational institution shall wear industrial quality eye protective devices at all times while participating in or observing any of the following courses:
>
> (A) Vocational, technical, industrial arts, fine arts, chemical, physical, or combined chemical-physical educational activities, involving exposure to:.....
>
> (6) Caustic or explosive materials;
>
> (B) Chemical, physical, or combined chemical-physical laboratories involving caustic or explosive materials, hot liquids or solids, injurious radiations, or other hazards.
>
> Such devices may be furnished for all students and teachers, purchased and sold at cost to students and teachers, or made available for a moderate rental fee, and shall be furnished for all visitors to such shops and laboratories.
>
> The superintendent of public instruction, or any other appropriate educational authority designated by the superintendent, shall prepare and circulate to each public

NOTES	INSTRUCTION
	and private educational institution in this state instructions and recommendations for implementing the eye safety provisions of this section. The Industrial Commission shall insure compliance with this section. Industrial quality eye protective devices, as used in this section, means devices meeting the standards of the American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1-1968, approved by the American National Standards Institute, Inc., and subsequent revisions thereof, provided such revisions are approved and adopted by the Industrial Commission."
Exhibit 5-2	As of July 1977, 36 states have enacted laws based upon the aforementioned model.
	Compliance with the Law
	The preceding paragraph cites the American National Standard, ANSI Z87.1 as was recommended in the NSPB model law. This Standard, developed primarily for industrial use, is the most sound basis for selecting eye protection fitted to the task and the hazard. Careful reading of the Standard and study of Exhibit W-5-2 will lead to a conclusion that splash resistant chemical goggles are the only

LESSON	NO. 5
NOTES	INSTRUCTION
	protective device adequate for general eye protection in the school laboratory. For severe exposures, rarely occurring in school laboratories, the additional protection of a face shield is required to protect the face as well as the eyes.

LESSON NO. 5

NOTES	INSTRUCTION

SAFETY GOGGLES

Goggles meeting the ANSI Standard are available in many different styles and can be purchased from several manufacturers. The type most commonly used in the school laboratory is a flexible soft-sided plastic model with a single large plastic lens.

Ventilation is necessary for comfort and good visibility, but openings must not permit entrance of chemical splash. Chemical goggles are available with baffled vents so that air can flow through but liquids will not enter.

Goggles can be worn over most prescription spectacles with the possible exception of some modern styles with extra large diameter lenses.

Care and Cleaning of Goggles

Clearly the preferred arrangement for supplying students with eye protection is to issue a pair of goggles to each student for the duration of the course. He should then wash them frequently and store them in a protected place.

NOTES	INSTRUCTION
	Where more than one student must use the same goggles, it is advisable to clean and sterilize them between wearings so that infection will not be spread. Cleaning solutions containing quaternary ammonium compounds are effective but require thorough rinsing before drying. (See Sec. 6.4.3 of ANSI Z-87.1) Some schools have installed wall cabinets for sterilizing goggles with ultraviolet light. These cabinets are expensive but may be used if sterilization time is carefully controlled. The cabinet has the advantage of furnishing storage for the goggles.

LESSON NO. 5

NOTES

INSTRUCTION

FACE SHIELDS

As indicated, a face shield for handling chemicals in the laboratory is best suited for wearing over goggles to protect the face when the splash hazard is considerable.

Face shields large enough to give effective protection to the eyes would be too cumbersome for convenient wearing in the laboratory.

One or two face shields should be available for the teacher to wear when the quantity of chemical handled is large or the reactivity hazard is appreciable.

NOTES

INSTRUCTION

CORRECTIVE EYEWEAR

Many students and teachers require prescription lenses to correct visual defects. Since January 1972 all such lenses are required to be impact resistant in accordance with a federal regulation.

However, they should not be regarded as safety glasses, since they fall far short of ANSI Standard Z87.1. They are safer for street wear, but they are not adequate for eye protection in the laboratory.

Many splashes and solid particles approach the eye from an angle or from underneath; hence, would not be stopped by the lense even if it is strong enough. It is estimated that a third of eye injuries are caused by another person or source, not what the injured is doing. This accounts for some of the diversity in approach angle.

Although some modern glasses have large lenses, most are less than 50 millimeters in diameter, much smaller than the lens of most goggles.

LESSON NO. 5

NOTES	INSTRUCTION
	If worn, corrective eyewear should be covered with chemical goggles.

LESSON	NO. 5
NOTES	**INSTRUCTION**

SAFETY GLASSES

Industrial quality safety glasses will withstand severe abuse but are more suited to the school shop than the laboratory.

Again, they are smaller than desired and furnish little protection from splashes at an angle. Safety glasses furnished in industry are often fitted with side shields, but these are usually not suited for chemicals. If safety glasses are worn in the laboratory, they should be covered with chemical goggles.

Safety glasses have saved many eyes in shops and other locations where solid particles and projectiles are the principal hazards, but they are not the proper choice for the school laboratory.

CONTACT LENSES

It has been argued that contact lenses offer protection from damage by particles and chemicals. Nothing could be more erroneous.

An eye that has received a chemical splash should be irrigated with water until the material has been completely washed out. This usually takes about 15 minutes. If a contact lens is in the affected eye, the chemical may be drawn under the lens by capillary attraction where it cannot be reached by water washing.

The lens must be removed to permit effective washing. Under the traumatic conditions with pain and fear as impediments it may be impossible for the victim or anyone else to remove the lens.

Clearly the only answer is to prevent the possibility of such an occurrence. Contact lenses should be discouraged or prohibited in the school laboratory. Students should wear spectacles for correction, covered by chemical goggles. If contact lenses are medically necessary and corrective glasses cannot be substituted for them, it is recommended that a physician's

LESSON	NO. 5
NOTES	INSTRUCTION
	statement to this fact be required from the student/parent. In this case the wearer of contact lenses should be identified as a precaution, should an accident occur.

LESSON NO. 5

NOTES	INSTRUCTION
	LASER EYE PROTECTION

LASER EYE PROTECTION

Lasers are used in some school laboratories. Eye protection in their use depends more upon the energy, wall absorption, and proper procedures than upon absorptive lenses. Each laser wave length requires a particular color and density lens; hence, lenses must be properly matched to the source, otherwise little or no protection is afforded.

Even with the correct lenses, one must never look directly into the beam.

LESSON NO. 5

NOTES

INSTRUCTION

EYEWASH FOUNTAINS

If all protective measures fail and a student or teacher gets a corrosive chemical in the eye, an eyewash device should be available for immediate and thorough washing of the eye.

An eyewash fountain is a permanently installed basin which has twin streams of water to gently wash the two eyes. The valve may be operated by hand or foot or by pushing a bar with the head.

Another useful arrangement is a 5-foot length of 1/2-inch rubber hose with an aerated nozzle for washing. The victim can lie down and have another person hold the eye open while he washes it.

At least one eyewash device should be in every science laboratory where chemicals are used. Speed is essential. With alkali splash the first 10-30 seconds are critical.

Eyewash stations consisting of a wall holder or bracket and a bottle containing boric acid or a buffer solution are of doubtful value.

LESSON NO. 5

NOTES	INSTRUCTION
	First, they contain too little liquid and, second, water alone is best. They are not recommended.

LESSON NO. 5

NOTES	INSTRUCTION

EYE PROTECTION POLICY

A clear, firm eye protection policy should be adopted by the school administration or by the Board. Enforcement must necessarily be the teacher's function.

A basic tenet should be "approved eye protection must be worn at all times by anyone in the laboratory." If the plan is to wear it only when needed, the whole concept will break down. You can't get the goggles on while the splash is moving toward you.

Some laboratories are used for both lecture and experiment. Wearing goggles during class period may seem burdensome and unnecessary, but failure to do so will inevitably lead to failure to use protection when it is needed.

The policy should follow the state law and regulations or, in the 14 states not having a school eye protection act, the NSPB model law should give guidance. ANSI Z87.1 should be followed for selection and purchasing of eye protective equipment.

LESSON	NO. 5
NOTES	**INSTRUCTION**
	REFERENCES American National Standard for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1968. Ohio Revised Code, Section 3313.643.

EXHIBIT 5-1. MODEL SCHOOL EYE SAFETY LAW

The following text is offered as a guide in planning and preparing legislation to require state-wide eye safety for all students and teachers using or visiting school and college laboratory and shop facilities. Comparable protection for the eyesight of visitors to such educational areas is also advocated.

An Act to enact legislation requiring all students and teachers to wear approved eye protective devices when participating in certain vocational, industrial arts, and chemical-physical laboratory courses of instruction.

Be it enacted by the legislature of the State of ______________:

SECTION 1. Every student and teacher in schools, colleges, universities, or other educational institutions, participating in or observing any of the following courses of instruction:

(A) Vocational, technical, industrial arts, chemical, or chemical-physical, involving exposure to:

1. Hot molten metals, or other molten materials;
2. Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials;
3. Heat treatment, tempering, or kiln firing of any metal or other materials;
4. Gas or electric arc welding, or other forms of welding processes;
5. Repair or servicing of any vehicle;
6. Caustic or explosive materials;

(B) Chemical, physical, or combined chemical-physical laboratories involving caustic or explosive materials, hot liquids or

Source: National Society for the Prevention of Blindness, Inc.
79 Madison Avenue, New York, N. Y. 10016

solids, injurious radiations, or other hazards not enumerated; is required to wear appropriate industrial quality eye protective devices at all times while participating in or observing such courses of instruction. Such devices may be furnished for all students and teachers, purchased and sold at cost to students and teachers, or made available for a moderate rental fee, and shall be furnished for all visitors to such shops and laboratories.

"Industrial quality eye protective devices," as used in this section, means devices meeting the standards of the American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1-1968, and subsequent revisions thereof, approved by the American National Standards Institute, Inc.

The State Commissioner or Superintendent of Public Instruction, or other appropriate educational authority shall prepare and circulate to each public and private educational institution in this State instructions and recommendations for implementing the eye safety provisions of this law.

EXHIBIT 5-2. *STATES WHICH HAVE ENACTED LAWS BASED UPON THE FOREGOING TEXT

1963 - Ohio

1964 - Maryland (amended 1965), Massachusetts

1965 - Alabama, Arkansas, California, Florida, Illinois, Iowa, New Jersey, Oklahoma, Pennsylvania, South Carolina, Texas, Utah

1966 - Delaware, Louisiana, New York, Rhode Island, Virginia

1967 - Connecticut, Indiana, Kansas, Minnesota (effective 1/1/68), Tennessee, Wyoming

1968 - Arizona

1969 - Colorado, North Carolina, Washington (State), South Dakota

1972 - Michigan

1973 - Wisconsin

1974 - Mississippi, Georgia

1976 - Missouri

Total: 36 States

NOTE: The American National Standards Institute, Inc., has superseded the United States of America Standards Institute, Inc. (formerly the American Standards Association). All standards approved by the two latter organizations continue in effect under the American National Standards Institute designation.

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*The following states have issued regulations only: Maine, New Mexico

5/77

PROCEDURES FOR HANDLING CHEMICAL REAGENTS NO. 6

METHODS Lecture and Discussion **LENGTH** 45 Minutes

PURPOSE Emphasize techniques that minimize the probability of laboratory injuries.

OBJECTIVES

Enable the teacher to ...

1) Identify proper techniques for the control of chemical hazards.
2) Discuss the problems of using personal protective equipment in the school laboratory.
3) Develop "ground rules" for laboratory work with chemicals.

SPECIAL TERMS

Chemical toxicity
Dangerous reaction
Dated receiving system
Purchasing philosophy
Respiratory protection
Route of entry
Time-sensitive reagent

INSTRUCTOR MATERIALS

Lesson Plan
Slides
Chalkboard, Chalk, Eraser
Projector (35mm) and Screen

TRAINEE MATERIALS Note-taking

CONTENTS

INTRODUCTION 6-3

INVENTORY CONTROL PROCEDURES 6-4

  Dated Receiving System 6-6

  Recordkeeping Detail 6-7

CHEMICAL STORAGE 6-9

PURCHASING PHILOSOPHIES 6-10

  Cost Versus Safety 6-10

SOURCE OF INFORMATION ON POTENTIALLY DANGEROUS REACTIONS 6-12

SOURCES OF INFORMATION ON CHEMICAL TOXICITY 6-14

BASIC TOXICOLOGY - ROUTES OF ENTRY 6-17

SAFETY EQUIPMENT 6-22

  Eye and Face Protection 6-22

  Respiratory Protection 6-24

  Body Protection 6-25

LABORATORY RULES WHICH RELATE TO THE HANDLING OF CHEMICAL REAGENTS. 6-27

REFERENCES 6-29

EXHIBIT 6-1 6-30

LESSON NO. 6

NOTES

INSTRUCTION

INTRODUCTION

Mishandling of chemical reagents has long been a problem in science laboratories of all types not only high school science laboratories. The literature describes many case histories of explosions, fires, poisonings, burns, and other bodily injuries caused by improper or careless handling of chemical reagents.

Misuse of chemical reagents

Misuse of chemical reagents does not necessarily involve just problems occurring while the reagents are actually being used. Misuse can also consist of improper chemical reagent storage, improper recordkeeping, improper labeling, and improper purchasing and procurement programs. The proper handling of chemical reagents is a total program in itself and which is comprised of procurement, recordkeeping, storage, education, usage and disposal elements.

LESSON NO. 6

NOTES	INSTRUCTION
	INVENTORY CONTROL PROCEDURES
Inventory records	A school science laboratory should have readily available inventory records which cover the chemical reagents in stock, the existing instrumentation, and miscellaneous items such as glassware, fire extinguishers, and personal protective devices. Inventory records are essential for school laboratories because of the constant turnover of students and the frequent turnover of instructors. There is no legal requirement that the school or teacher keep records of this nature. However, these records can be extremely advantageous to the laboratory instructor and the school administration. Adequate written records allow inventory searches to be made rapidly. As the hazards presented by certain chemicals become recognized, it may become necessary to remove the chemical compounds from school shelves. A case in point is the list of proscribed carcinogens developed by OSHA. Many school science

LESSON NO. 6

NOTES

INSTRUCTION

laboratories contained one or more of these compounds, and the instructors were, and in many cases still are, unaware of the potential hazards. As more compounds are placed on the proscribed list, more compounds will have to be removed from the shelves of high school science laboratories.

A uniform, orderly system of recording purchase dates, receiving dates, quantities received, quantities used, and disposal date is necessary if the school and the instructor are to keep up with the ever-increasing flow of information on hazardous chemicals. As a companion to the OSHA list of proscribed carcinogens, the National Institute for Occupational Safety and Health (NIOSH) publishes a list of suspected carcinogens available through the Division of Technical Services, NIOSH, Cincinnati, Ohio 45226. These are chemical compounds or elements that are suspected of causing cancer in laboratory animals. The use of these compounds should be restricted where possible.

Suspected carcinogens

Christensen (1975)

LESSON NO. 6

NOTES	INSTRUCTION

Dated Receiving System

Time-sensitive reagents

All chemical reagents, upon receipt in the laboratory, should be immediately marked with the receiving date. The reason for dating the reagent is the time sensitivity of certain chemical reagents. Many chemical reagents are oxidized by atmospheric oxygen over a period of time. The effect of this can be minimal, i.e., the reagent will not perform properly in a chemical test and a new batch of reagent will have to be acquired or prepared. An example of the minimal effect of time sensitivity is the oxidation of o-tolidine. Once oxidized, this material will not perform properly in colorimetric procedures utilizing it as one of the color forming agents.

Peroxides

On the other hand, some materials are time sensitive in a dangerous fashion. Ethyl ether and dioxane, for example, form explosive peroxides after sitting for varying periods of time. These chemical compounds should be disposed of before peroxides can form. An inventory control system would allow the routine removal and disposal of time sensitive chemical compounds. Manufacturers or suppliers can supply specific information relating to these problems.

Recordkeeping Detail

The amount of time which an instructor can devote to maintaining chemical usage and inventory records is limited. If the instructor wants to maintain a complete records system, he or she may have to devote considerable time to it.

Student involvement

There should be a record for each chemical reagent which lists the date received, quantities withdrawn, when withdrawn and by whom, the date disposed of and the disposal method. Ideally, students could get involved in the recordkeeping system and remove much of the burden from the instructor's shoulders.

Inventory records could be designed to contain more information. They could list special precautions to take in handling the chemical, toxicity data, and safety data. Compiling these

LESSON **NO.** 6

NOTES	INSTRUCTION
	types of information might be prohibitive for the average science instructor, but it might serve as a useful project for one or more students.

LESSON NO. 6

NOTES

INSTRUCTION

CHEMICAL STORAGE

The storage of chemical reagents is a key element in a program of safe and proper chemical usage. Proper storage is an item frequently overlooked not only in school science laboratories, but in all science laboratories. The functions of chemical storage are three in number:

(1) They provide security against unauthorized removal of chemicals by students or others;

(2) They protect the outside environment by restricting emissions from stored chemicals;

(3) They protect the reagents from fire. An ideal chemical storage system will fulfill all three functions and require a minimal expenditure of funds.

Satisfactory storage for chemical reagents in school science laboratories can be achieved with a specially constructed central storage room or with commercial flammable storage cabinets.

LESSON	NO. 6

NOTES	INSTRUCTION

PURCHASING PHILOSOPHIES

Procurement programs generally have one fundamental rule: get the greatest quantity for the lowest possible price. Only occasionally are other factors considered important enough to override the "lowest possible price" rule. The purchase of chemical reagents is one area where the cost factor is frequently outweighed by safety and health considerations.

Cost Versus Safety

Chemical reagents can be purchased at a much lower cost per unit size in bulk quantities than in smaller quantities. Purchasing chemical reagents in bulk quantities may be a very poor practice if the rate of usage of those particular reagents does not result in their consumption in a reasonable amount of time.

From a safety standpoint, chemical reagents should be purchased in the smallest quantities possible consistent with the manner in which they are used. This holds for both flammable and non-flammable chemical reagents. For high

LESSON	NO. 6
NOTES	INSTRUCTION
	school science laboratories, a semester's supply of chemical reagents would constitute a satisfactory supply for most situations.

NOTES	INSTRUCTION
	SOURCE OF INFORMATION ON POTENTIALLY DANGEROUS REACTIONS Frequently accidents occur in the science laboratory simply because neither the instructor nor the student knows or is able to anticipate the effects of a particular chemical combination. This is not an uncommon situation even among highly experienced chemists. One of the primary goals of any school science safety program should be to minimize the frequency and severity of accidents which result from a lack of knowledge. Data on chemical reactions and incompatible chemical compounds and elements has been collected in several publications (Page 6-13). This information should be readily available to all high school science instructors and should be used by them whenever necessary, so that bodily injuries and property damage resulting from unexpected chemical reactions can be eliminated as much as possible. Exhibit 6-1 presents a partial list of chemical incompatibilities. This is not an all inclusive list. The references below should

be consulted in case of doubt about a particular reaction.

The following publications are excellent sources of information on hazardous chemical reactions.

National Fire Protection Association: Hazardous Chemicals Data 1975. NFPA No. 49. National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210. (1975).

National Fire Protection Association: Manual of Hazardous Chemical Reactions 1975. NFPA No. 491M. National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210. (1975).

Manufacturing Chemists Association: Guide for Safety in the Chemical Laboratory, 2ed. Van Nostrand Reinhold Company, New York, New York (1972).

Steere, N.V. ed.: Handbook of Laboratory Safety, 2d ed. The Chemical Rubber Co., Cleveland, Ohio (1971).

Stecher, D.G., Ed.: The Merck Index. Merck & Co. Inc., Rahway, N.J. (1968).

Meyer, E.: Chemistry of Hazardous Materials. Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1977).

LESSON NO. 6

NOTES	INSTRUCTION

SOURCES OF INFORMATION ON CHEMICAL TOXICITY

Safety Hazards in laboratories have been recognized for many years. On the other hand, the health hazards presented by many of the common chemical reagents found in high school science laboratories have been largely ignored.

Many of the common laboratory reagents do present significant health hazards to students and instructors. For example, benzene has recently been tagged as a carcinogen. Trichloroethylene, a common solvent, has also been designated as a potential carcinogen. Other common chemical reagents found in high school science laboratories are considered as safety hazards rather than health hazards. Carbon disulfide is an excellent example of this. Warnings covering the use of carbon disulfide stress its volatility and flammability. Carbon disulfide is a highly toxic chemical compound that can enter the body through the skin or through the respiratory tract. Carbon disulfide can damage the liver and kidneys and the central nervous system.

NOTES	INSTRUCTION
	The following publications contain information on the toxicities of chemical compounds. The proper interpretation of toxicity information and data may require expertise that is beyond that ordinarily possessed by high school science instructors. In that case expert advice should be sought either through the appropriate state officials or through the National Institute for Occupational Safety and Health.

Christiansen, H.E., ed., and T. Luginbyhl, ed.: Registry of Toxic Effects of Chemical Substances. U.S. Department of Health, Education and Welfare, Public Health Service, National Institute for Occupational Safety and Health. Rockville, Maryland 20857 (June, 1975).

Christensen, H.E. ed., and T. Luginbyhl, ed.: Suspected Carcinogens, A Subfile of the NIOSH Toxic Substances List. U.S. Department of Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health. Rockville, Maryland 20857 (June, 1975).

Gafafer, W.M. ed.: Occupational Diseases, A Guide to their Recognition. U.S. Department of Health, Education, and Welfare, Public Health Service PHS Publication No. 1097. (1966).

Stecher, P.G., ed.: The Merck Index. Eighth Ed. Merck & Co., Inc. Rahway, N.J. (1968).

LESSON	NO. 6
NOTES	**INSTRUCTION**
	Casarett, L.J., ed., and J. Doull, ed.: Toxicology, The Basic Sciences of Poisons. Macmillan Publishing Co., Inc. New York, New York (1975).

LESSON NO. 6

NOTES	INSTRUCTION

BASIC TOXICOLOGY - ROUTES OF ENTRY

If the health hazards presented by chemical reagents found in high school science laboratories are going to be appreciated and understood by those using the reagents, an understanding of some basic toxicological principles is necessary.

A chemical health hazard can exhibit many different effects on the human body. Health Hazards can be classified as nuisances, irritants, corrosives, anesthetics, allergens, carcinogens, mutagens, teratogens, toxins, or central nervous system depressants. These are not all the possible classifications, but are only a representative selection of possible classifications.

Toxic agents can enter the body in three ways: (1) through the digestive tract; (2) through the respiratory tract; and (3) through the skin. The most common route of entry is through the respiratory tract. The other two are less common but still present serious problems.

NOTES	INSTRUCTION
	Food should never be eaten in science laboratories because of the danger of accidentally ingesting toxic chemical compounds. Individuals do not ordinarily willingly ingest hazardous substances so this problem can be controlled by not allowing the consumption of food and drink in the laboratory. Another practice which should not be allowed in science laboratories is smoking. Aside from the obvious safety hazard presented by burning cigarettes and flammable liquids, cigarettes have been indicted in several industrial poisoning incidents. Toxic materials can be transferred from dirty hands to cigarettes and then to the digestive tract. Since smoking must not be allowed in science laboratories the problem of ingestion should not arise in high school science laboratories. The absorption of chemical reagents through the skin can be a serious problem in science laboratories. Many chemical reagents, principally liquids but some solids as well, readily pass through the skin barrier into the bloodstream. Compounds that are especially dangerous

NOTES	INSTRUCTION
	because of their ability to penetrate the skin include methyl alcohol, butyl alcohol, methyl acrylate, perchloroethylene, tetraethyl lead, carbon disulfide, benzene, and nearly all pesticides. The list of proscribed contaminants published by the Occupational Safety and Health Administration of the U.S. Department of Labor (29 C.F.R. 1918.1000) designates a number of chemical compounds as skin absorption hazards. Skin absorption occurs when laboratory workers are careless with chemical reagents or deliberately misuse them. For example, organic solvents are commonly used for cleaning purposes in laboratories. During the cleaning operations, hands are often dipped into the solvent, and substantial quantities of solvent may be spilled on the hands and other parts of the body. The control of skin absorption as a route of entry is primarily a procedural matter involving the use of proper personal protective equipment and common sense. Educating students in the proper handling of substances to eliminate or reduce the skin absorption hazard is the best technique for dealing with this problem.

NOTES	INSTRUCTION
	Inhalation of toxic vapors, gases, or aerosols is the most common route of entry into the body for toxic materials. Vapors are readily found in every science laboratory. There is no practical way to eliminate them. A vapor is the gaseous phase of a substance that is a solid or liquid at normal temperature and pressure. Vapors can be reduced by carrying out experiments in functioning exhaust hoods and by ventilating chemical storage areas. Gases are substances whose normal state is a gas at standard temperature and pressure (25°C, 760 mmHg). The control of gases is accomplished with exhaust hoods and ventilated storage areas. Gases include some of the most toxic chemical compounds known. Phosgene, phosphine, vinyl chloride, hydrogen cyanide, chlorine, and hydrogen sulfide are all gases, and they are all hazardous. Aerosols present a very significant inhalation hazard in the science laboratory. An aerosol is a dispersion of solid or liquid particles in air. Aerosols are produced by pouring or stirring liquids and by handling

LESSON NO. 6

NOTES	INSTRUCTION
	powders or solid materials. Aerosols can also be controlled by exhaust hoods and ventilation systems. Even if adequate control equipment in the form of exhaust hoods and personal protective devices is available, proper procedural techniques must be taught to the students. Students must be taught that caution and care in the laboratory are as much a part of any experimental work as the chemical reagents. A typical procedural technique that students must be taught is to use the proper regulator on compressed gas tanks. The use of the wrong regulator can result in corrosion of the regulator and gas leakage.

LESSON NO. 6

NOTES	INSTRUCTION
	SAFETY EQUIPMENT

SAFETY EQUIPMENT

The use of safety equipment by students and instructors in high school science laboratories is an integral part of a laboratory safety program. Safety equipment is a broad designation that includes exhaust hoods, personal protective devices such as respirators and safety eyeglasses, and fire extinguishers. Exhaust hoods and fire extinguishers are discussed in detail in other lesson modules.

Eye and Face Protection

Thirty-six states have enacted legislation which requires the wearing of protective eye wear or face shields by students working in high school science laboratories. Goggles serve to provide the wearer minimum protection against solid particles or liquid droplets which could enter the eye. Explosions, dropped glassware, and other accidents can all serve as the source of flying particles. Industrial quality eye protection must be worn at all times by all people in the laboratory. It does not matter

NOTES	INSTRUCTION
	that the wearer might be engaged in a relatively innocuous task; as slong as he is in the laboratory, he must wear appropriate eye protection. Contact lenses should not be worn in the science laboratory. If a corrosive liquid is splashed into the eye, it may become trapped behind the contact lens and do more damage than it would to an eye without the contact lens. Face shields are curved sheets of plastic which protect the entire face of the wearer. They are commonly worn when using concentrated acids and alkalies and when working with unknown reactions. The face shields are worn only when necessary and serve as an added safeguard along with the safety glasses. The instructor must establish rules governing the use of face shields. There are various types of barrier shields which are generally constructed of plexiglass or polycarbonate plastics. The shields are movable, self-supporting devices which can be placed between the worker or student and the experiment he or she is working on. If an explosion or accident occurs, the worker's body and face are

protected. The hands may be the only vulnerable portion of the body when barrier shields are used.

Respiratory Protection

Generally respiratory protection is not needed in high school science laboratories except in cases of accident. Because the possibility of a serious accident always exists in any laboratory, some type of respiratory protection should be maintained on hand at all times. Respiratory protection is furnished to the user or wearer by a mask which performs one of more of the following functions - filters particles, removes vapors and gases by adsorption, and supplies air or oxygen.

High school science laboratories can protect themselves with dual cartridge respirators which possess a mechanical filtering capacity and a limited adsorption capacity for gases and vapors. Self-contained respirators which deliver a regulated flow of clean air are extremely expensive and bulky. Their use is

NOTES

INSTRUCTION

not practical in high school science laboratories.

Body Protection

There are a multitude of devices for protecting students and instructors against the corrosive or toxic effects of chemical reagents. One of the most common protective devices is the laboratory apron. Aprons should be worn by all students working in a laboratory especially when working with corrosive reagents.

Gloves should be worn by students when working with corrosive reagents. Gloves have a tendency to reduce dexterity which may be a hazard in itself. Gloves are generally rubber or plastic.

Because the laboratory is a relatively hazardous environment, instructors and students should make every effort to reduce the chances of accident or exposure. Long hair can be a serious hazard in a laboratory. Fire and reduced visibility are just two of the hazards that result from long hair.

LESSON NO. 6

NOTES	INSTRUCTION
	Loose clothing is another potential safety hazard in the laboratory. Loose clothing is less controllable than tight-fitting clothing. Glassware can be knocked off benches, clothes can come into contact with open flame, and manual dexterity can be reduced.

LESSON NO. 6

NOTES

INSTRUCTION

LABORATORY RULES WHICH RELATE TO THE HANDLING OF CHEMICAL REAGENTS

The following rules are typical examples of school laboratory safety and health rules which are found in school science textbooks and laboratory manuals.

1. Do only the experiment authorized by the teacher.

2. If acid or another corrosive material is spilled, wash it off immediately with water.

3. Do not touch chemicals with your hands unless directed to do so.

4. Do not taste chemicals unless directed to do so.

5. Throw all solids and paper to be discarded into a waste jar or wastebasket. Never discard matches, filter paper, or any slightly soluble solids into the sink.

6. Check the label on a reagent bottle carefully before removing any of the contents. Read the label twice to make sure you have the right bottle.

7. Never return unused chemicals to stock bottles.

LESSON NO. 6

NOTES

INSTRUCTION

8. Wear protective eye goggles and use a fume hood where necessary.

9. Never point the open end of a test tube being heated at anyone.

These rules demonstrate the care that must be taken when handling chemical reagents. These rules are not all inclusive. They are merely examples culled from a number of high school science textbooks. It is up to each individual teacher to elaborate on them to make them applicable to his or her own situation.

LESSON NO. 6

NOTES	INSTRUCTION

REFERENCES

Christensen, H.E. and T. Luginbyhl, Ed.: *Suspected Carcinogens, A Subfile of the NIOSH Toxic Substances List*. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Rockville, Maryland (1975).

Manufacturing Chemists Association: *Guide for Safety in the Chemical Laboratory*, 2d ed. Van Nostrand Reinhold Co., New York, N. Y. (1972).

Steere, N.V. ed.: *Handbook of Laboratory Safety*, 2d ed. The Chemical Rubber Co., Cleveland, Ohio (1971).

EXHIBIT 6-1: EXAMPLES OF INCOMPATIBLE CHEMICALS

Chemical	Keep Out of Contact With:
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, glycol, perchloric acid, peroxides, permanganates
Alkaline metals, such as powdered aluminum or magnesium, sodium, potassium	Water, carbon tetrachloride or other chlorinated hydrocarbon, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury (in manometers, for instance), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Carbon, activated	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, metals powders, sulfur, finely divided organic or combustible materials
Chromic acid	Acetic acid, naphthaline, camphor, glycerin, turpentine, alcohol, flammable liquids in general
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, the halogens
Hydrocarbons (butane, propane, benzene, gasoline, turpentine, etc.	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, combustible materials
Mercury	Acetylene, fulminic acid, ammonia
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases
Potassium chlorate	Sulfuric and other acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium)

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

STORAGE AND DISPOSAL OF CHEMICALS REAGENTS NO. 7

METHODS Lecture and Discussion

LENGTH 30 Minutes

PURPOSE Present the basic principles of proper chemical storage and disposal.

OBJECTIVES Enable the trainee to ...

1) Name and describe the elements of a proper storage system.

2) Compare and contrast good and poor storage disposal practices.

3) Estimate the changes required in current facilities for chemical storage and disposal.

SPECIAL TERMS

Environmental control
Explosion-proof refrigerator
Fire code
Inventory control
Safety cabinet

INSTRUCTOR MATERIALS Lesson Plan

Chalkboard, Chalk, Eraser

TRAINEE MATERIALS Note-taking

CONTENTS

INTRODUCTION 7-3

MATERIALS OF CONSTRUCTION 7-4

VENTILATION AND ENVIRONMENTAL CONTROL 7-8

ARRANGEMENT OF REAGENTS 7-9

USE OF COMMERCIAL STORAGE CABINETS 7-10

POOR STORAGE PRACTICES 7-13

    Hood Storage of Reagents 7-13

    Food in Refrigerators 7-14

    Flammable Reagents in Standard Refrigerators 7-14

RADIOACTIVE MATERIAL STORAGE 7-16

DISPOSAL OF UNWANTED CHEMICALS 7-17

    State Laws Governing Waste Disposal. 7-17

    Disposal Choices 7-21

    Disposal Techniques-Toxic and Hazardous Chemicals 7-22

REFERENCES 7-23

EXHIBITS

7-1: CONSTRUCTION AND FIRE PROTECTION REQUIREMENTS FOR LABORATORY UNITS 7-24

7-2: CONCENTRATION IN AIR AND WATER ABOVE NATURAL BACKGROUND 7-25

7-3: ALLOWABLE CONCENTRATIONS ABOVE BACKGROUND 7-31

LESSON NO. 7

NOTES	INSTRUCTION
	INTRODUCTION
Three critical elements	Inside central storage rooms for chemical reagents are desirable for educational institutions. Inside storage rooms allow the use of an inventory control system and provide fire protection and security. There are three critical elements which must be dealt with when designing and constructing inside storage facilities. These are fire protection, chemical exposure protection, and protection against criminal acts.
Fire protection	Fire protection is handled by using the proper materials of construction, providing for ventilation, and providing for a fire extinguishing system.
Chemical exposure protection	Chemical exposure protection can be handled by controlling the types of chemicals stored and providing for ventilation of the storage room.
Security	Security is handled by providing for a sturdy door with a good lock.

LESSON NO. 7

NOTES	INSTRUCTION
	MATERIALS OF CONSTRUCTION
	In most educational institutions, both flammable and non-flammable chemical reagents will be stored in the same storage area. Therefore the storage area should be designed in such a manner that it effectively deals with the three key element of chemical storage discussed above.
NFPA, Flammable Liquids, No. 30, Section 44 NFPA storage provisions	The National Fire Protection Association (NFPA) publishes standards which govern fire protection in educational institutions. The NFPA code states that the storage of flammable liquids shall be limited to that required for maintenance, demonstration, treatment, and laboratory work. The code establishes the following storage provisions for flammable liquids:
	(1) No container shall exceed a capacity of one gallon.
	(2) Not more than 10 gallons of flammable or combustible liquids shall be stored outside of a storage cabinet or storage room except in safety cans.

LESSON NO. 7

NOTES	INSTRUCTION
	(3) Not more than 25 gallons of flammable or combustible liquids shall be stored in safety cans outside of a storage room or storage cabinet.
	(4) Quantities of flammable and combustible liquids in excess of those set forth in this section shall be stored in an inside storage room or storage cabinet.
	For purposes of fire protection, when flammable liquids are stored, the NFPA code requires that:
Storage room construction requirements	(1) The floor in the storage room be at least four inches lower than the floors of the surrounding rooms and corridors or that there be a four-inch high sill between the storage area and adjacent areas.
NFPA, Flammable Liquids, No. 30, Section 43	(2) All doors be approved, self-closing fire doors.
	(3) The room be liquid-tight where the walls join the floors.
	The code also specifies that storage rooms with a maximum floor area of 150 square feet must have walls, floor, and ceiling with a fire resistive rating of at least one hour. Larger storerooms must have a fire-resistive rating of

LESSON NO. 7

NOTES

INSTRUCTION

at least two hours. The quantities of flammable liquids stored are limited by the code to two gallons per square foot of floor area for storage rooms less than 150 square feet in area. If the storage room has a fire protection system, however, the quantity stored can be increased to five gallons per square foot. A fire protection system is a sprinkler system, a carbon dioxide foam system, or any similar automatic system that is acceptable to the local authorities.

For storage areas with a floor area between 150 and 500 square feet, the fire resistance of the walls, floor and ceilings must be at least two hours. For unprotected areas the allowable loading is limited to four gallons per square foot, and, for fire protected areas, it is limited to 10 gallons per square foot.

NFPA, Laboratories Using Chemicals (1976)

The floors in storage rooms should be constructed out of material that possesses good chemical resistance and is readily cleaned. All electrical outlets and equipment must be well grounded.

If there are no special, central storage

NOTES	INSTRUCTION
	areas for chemical storage, and flammable liquids are stored or used in a school science laboratory, the laboratory must be separated from non-laboratory areas by construction having not less than one hour fire resistance. Exhibit 7-1 presents the construction and fire protection requirements for laboratory units.

LESSON NO. 7

NOTES	INSTRUCTION
	VENTILATION AND ENVIRONMENTAL CONTROL All inside storage rooms should be equipped with a gravity exhaust system or a mechanical exhaust system to remove hazardous vapors. The exhaust duct should be located near the floor level (one foot above). The supply air duct should be located on the opposite wall in a position which will minimize short-circuiting of the air flow pattern.
NFPA exhaust requirements	The NFPA code requires that the exhaust system be capable of at least six changes of room air per hour.
NFPA, Flammable Liquids, No. 30, Section 43	If flammable liquids with flash points below 38°C (100°F) are stored, mechanical exhaust ventilation should be used. As a rule of thumb, the ventilation system should be capable of removing 10,000 cubic feet of air for every gallon of liquid vaporized.
	The room should be kept cool but not cold enough to freeze the reagents stored therein.

LESSON NO. 7

NOTES	INSTRUCTION

ARRANGEMENT OF REAGENTS

Incompatible chemicals

Many science laboratories store reagents on the shelves in alphabetical order to facilitate retrieval of individual chemicals. Although it is a convenient system for storage and retrieval, it may result in incompatible chemicals being stored close to one another. For example, strong, oxidizing materials should not be stored next to organic materials. Instructors must be aware of this possibility. Potentially hazardous chemicals should be segregated from the less dangerous. This does not mean that they have to be stored in another room or cabinet. They can be stored on another shelf or on the other side of the room.

Large containers should be stored on or near the floor. The higher shelves should not be higher than an average-sized person can comfortably reach while standing on the floor. Only smaller containers should be stored on the higher shelves.

LESSON NO. 7

NOTES	INSTRUCTION
	USE OF COMMERCIAL STORAGE CABINETS
Metal cabinets	Special cabinets are available for storing flammable and combustible liquids both in laboratories and in storerooms. These commercial cabinets are double-walled, metal cabinets made of gauge sheet steel and equipped with a lock.
NFPA, Flammable Chemicals, No. 30, Section 43	According to the NFPA, these cabinets should be designed so that the internal temperature does not exceed 325°F when subjected to a ten-minute fire test using the standard time-temperature curve specified by NFPA. The code requires that the bottom, top, door, and sides of the cabinet be double-walled with at least a 1.5 inch air space between the walls.
Wooden cabinets	The NFPA code also allows the use of wooden cabinets. Tests made by the Los Angeles Fire Department have shown properly constructed wooden cabinets to be at least as effective, and in many cases better, than the steel cabinets.

The NFPA specifies that all wood cabinets used for the storage of flammable liquids be constructed of wood at least one inch thick. The Los Angeles Fire Department specifies that wood cabinets used for the storage of "dangerous" chemicals be constructed of wood at least two inches thick, and wood cabinets used for the storage of flammable chemicals be at least one inch thick.

The NFPA code specifies that not more than 60 gallons of flammable or 120 gallons of combustible liquids may be stored in a storage cabinet.

Storage cabinets provide a convenient method for storing flammable and toxic chemicals when a central storage facility is not available. They are equipped with a lock and provide excellent security in school situations. They are also equipped with plumbing connections which facilitate the connection of the cabinets to a mechanical exhaust system. The cabinets should be exhausted to prevent the accumulation of toxic or explosive chemical vapors. One

NOTES	INSTRUCTION
	manufacturer of flammable storage cabinets recommends that they be exhausted at a rate of 20 cubic feet per minute (cfm).

LESSON NO. 7

NOTES | INSTRUCTION

POOR STORAGE PRACTICES

Hood Storage of Reagents

In most school science laboratories, the fume hoods are used for storing chemical reagents at least part of the time. This is a practice which should be discouraged. Most school fume hood systems are not designed to operate 24 hours a day, seven days a week. If hoods are going to be used for storage, they must operate continuously or volatile, flammable chemicals cannot be stored in them.

Other problems that occur when hoods are used for storage include the loss of labels due to the corrosive environment frequently found in hoods, the loss of space needed for laboratory work because it has been devoted to storing reagents, and possible hazards from storing or using incompatible chemicals. Hoods also do not provide any security for chemical reagents. Storing chemical reagents in hoods should be done only on a temporary basis. It is not a recommended practice.

LESSON NO. 7

NOTES	INSTRUCTION

Food in Refrigerators

Food for human consumption should never be stored in refrigerators used for the storage of chemical reagents or biological materials. The chances of contaminating the food are too great to allow this practice. With all of the hazards existing in a high school science laboratory, there is no point in adding the danger of ingestion of toxic materials.

Flammable Reagents in Standard Refrigerators

Refrigerators are commonly found in biological and chemical science laboratories. They are used to store biological materials, volatile chemical reagents, and heat-sensitive chemical reagents.

Refrigerators used in laboratories should be of the explosion-proof or explosion-safe design. Explosion-proof refrigerators can be used in dangerous atmospheres, all possible sources of ignition, both inside and out, are sealed. Explosion-safe refrigerators can be

LESSON	NO. 7
NOTES	INSTRUCTION
	used to store flammable materials, but cannot be used in hazardous atmospheres. Standard, household or commercial refrigerators should not be used in school science laboratories. Flammable liquids should never be stored in standard refrigerators. The light switches, the lights themselves, and the thermostat can serve as ignition sources in standard refrigerators.

RADIOACTIVE MATERIAL STORAGE

The possession and use of radioactive material is regulated by law in all states. Educational institutions must take special care with radioactive materials. Radioactive materials include some of the most hazardous materials on earth. There are two key elements in protecting users and the general public from the health hazards of radiation. These are security and shielding.

Security is important because radioactive materials must be kept out of the wrong hands. Radioactive materials must always be stored in locked cabinets, drawers, or boxes.

The hazards of exposure to radiation are well-documented; it is not necessary to repeat them here. Each state as well as the federal government has regulations governing the acquisition, possession, and use of radioactive materials. Each school must comply with the regulations of its own particular state.

DISPOSAL OF UNWANTED CHEMICALS

One of the most important aspects of laboratory operation is disposing of waste chemicals. Toxic and hazardous wastes can be difficult to get rid of. They can also be very costly to get rid of. The disposal of hazardous chemicals is strictly regulated by law in most states.

State Laws Governing Waste Disposal

The disposal of toxic and hazardous laboratory wastes is restricted by law in many states. Before an instructor orders his students to dump hazardous material into the sink and flush it down the drain or to pour hazardous or toxic material onto the ground, he or she had better check to see whether such actions will violate applicable state or municipal laws.

Many states have laws which regulate the discharge of toxic and hazardous materials into sewerage systems and receiving waters and the atmosphere. It is impossible to review the regulations of all states; so a representative number will be presented.

Ohio Air Pollution Regulation

Ohio Air Pollution Regulation AP-5-07 (G) (2) covers the emission of hydrocarbon materials in Ohio. It states that:

> "A person shall not discharge more than 40 pounds of organic material into the atmosphere in any one day, nor amore than 8 pounds in any one hour .... unless such discharge had been reduced by at least 85 per cent."

Eight pounds may seem like a lot of material, but it represents approximately one gallon of waste solvent. It is very easy to accumulate one gallon of liquid hydrocarbon waste.

Rhode Island Solvent Regulation

The Rhode Island Organic Solvent Regulation (Regulation 15) states that:

> "A person ... shall not discharge into the atmosphere more than 40 pounds of organic material per day ..."

These air pollution regulations are typical of hydrocarbon emission regulations promulgated by many of the states. If an instructor is thinking of handling the disposal of liquid organic

LESSON NO. 7

NOTES	INSTRUCTION

solvents by evaporation, he or she would do well to check the state and local regulations which control hydrocarbon disposal by this method.

There are analogous regulations which govern the disposal of toxic or hazardous wastes into water bodies.

Georgia Water Quality Act

Section 21 A (2) of the Georgia Water Quality Control Act states that:

> "Any person who intentionally, negligently, or accidentally causes or permits any toxic, corrosive, acidic, caustic, or bacterial substance to be spilled, discharged, or deposited in the waters of the State ... in amounts or concentrations harmful to the public health ... shall be strictly liable in damages to the State ..."

Illinois Regulations

Illinois has both general and specific regulations governing discharges to sewerage systems.

Part VII, Section 701 (a) of the Illinois Water Pollution Control Rules prohibits the discharge of "liquids, solids, or gases which by reason of their nature or quantity may cause fire or explosion; or be injurious in any other way to sewers, treatment works structures; or cause a safety hazard to the personnel operating the treatment works ...."

Section 702 of the Illinois rules states that no effluent to any public sewer system shall include mercury or any of its compounds in excess of 0.0005 milligrams per liter as mercury at any time.

Section 703 of the Illinois rules states that no waste to any public sewer system shall contain cyanide in excess of 0.025 milligrams per liter at any time.

Massachusetts regulation

Massachusetts has a regulation (Hazardous Waste Regulation 5.5) which requires that hazardous chemical, biological, and radioactive wastes be consolidated for recovery or detoxified or otherwise pretreated to make them suitable for conventional waste treatment.

Local regulations

Not only state laws must be considered before disposing of hazardous chemicals but also county, municipal and waste disposal district regulations. The local regulations may be much more restrictive than the state regulations. It is the instructor's duty to research the applicable laws and regulations that pertain to his or her school district.

Disposal Choices

School science teachers have two basic disposal pathways open to them. They can handle the disposal themselves or they can pay a commercial disposal service to handle it for them. The first approach is time consuming and the second is usually relatively expensive.

The disposal of waste or outdated chemicals can be a valuable educational experience for instructors and students alike. Formal instruction in the disposal of waste chemicals should be a fundamental part of every experimental lesson.

If a school has an extremely large quantity of chemical reagents that must be disposed of, a commercial disposal service may be the answer. However before a commercial service is contracted for, their abilities and background

NOTES	INSTRUCTION
	should be investigated as much as possible. Many commercial disposal services have been discredited because they collect waste chemicals and dispose of them by dumping them into the local sewerage system or landfill without any pretreatment.
	Disposal Techniques-Toxic and Hazardous Chemicals
MCA (1973)	The availability of information on disposal techniques for laboratory chemical reagents is limited. The best information available in this area is the disposal scheme developed by the Manufacturing Chemists Association and published in Laboratory Waste Disposal Manual. (See Basic References in Appendix B.)

LESSON	NO. 7
NOTES	INSTRUCTION
	REFERENCES

Manufacturing Chemists Association: Laboratory Waste Disposal Manual. MCA, Washington, D.C. (1973).

National Fire Protection Association: National Fire Codes, Vol. 1, Flammable Liquids. NFPA, Boston, Massachusetts (1966).

National Fire Protection Association: Standard on Fire Protection for Laboratories Using Chemicals. No. 45. NFPA, Boston, Massachusetts (1976).

Nuclear Regulatory Commission: Standards for Protection Against Radiation. 10 CFR 20.

EXHIBIT 7-1: CONSTRUCTION AND FIRE PROTECTION REQUIREMENTS FOR LABORATORY UNITS

Laboratory Unit Class	Area of Laboratory Unit	**Nonsprinklered Laboratory Units**				**Sprinklered Laboratory Units**[2]	
		In Fire-resistive, Protected Noncombustible or Noncombustible Buildings		In Heavy Timber, Ordinary or Wood Frame Buildings		Any Building or Laboratory Construction	
		Separation from Nonlaboratory Areas[3]	Separation from Laboratory Units of Equal or Lower Hazard Class[3]	Separation from Nonlaboratory Areas[3]	Separation from Laboratory Units of Equal or Lower Hazard Class[3]	Separation from Nonlaboratory Areas[3]	Separation from Laboratory Units of Equal or Lower Hazard Class[3]
A	Under 1000 Sq. Ft.	1 Hour	1 Hour	2 Hours	1 Hour	1 Hour	Noncombustible[4]
	1000–2000 Sq. Ft.	1 Hour	1 Hour	Not Permitted		1 Hour	Noncombustible[4]
	2001–5000 Sq. Ft.	2 Hour	1 Hour	Not Permitted		1 Hour	Noncombustible[4]
	5001–10,000 Sq. Ft.	Not Permitted		Not Permitted		1 Hour	1 Hour
	10,000 or more Sq. Ft.	Not Permitted		Not Permitted		Not Permitted	
B	Under 20,000 Sq. Ft.	1 Hour	Noncombustible[4]	1 Hour	1 Hour	Non-comb.[4, 5]	Noncombustible[4]
	20,000 or more Sq. Ft.	Not Permitted		Not Permitted		Not Permitted	
C	Under 10,000 Sq. Ft.	1 Hour	Noncombustible[4]	1 Hour	Noncombustible[4]	Non-comb.[4, 5]	No Requirement
	10,000 or more Sq. Ft.	1 Hour	Noncombustible[4]	1 Hour	1 Hour	Non-comb.[4, 5]	Noncombustible[4]

[1] Where a laboratory unit contains an explosion hazard, appropriate explosion protection shall be provided for adjoining laboratory units and nonlaboratory areas as specified in Chapter 5.

[2] In laboratory units where water creates a serious fire or personnel hazard, a nonwater extinguishing system may be substituted for sprinklers.

[3] For a discussion of fire resistance of building materials, including the resistance of wall, partition, floor and ceiling construction see "Fire Protection Handbook," Boston, NFPA, 1969, Thirteenth Edition, pages 8-86 — 8-124.

[4] May be ½-hour rated combustible construction in lieu of noncombustible construction separation.

[5] In educational occupancies laboratory units shall be separated from nonlaboratory areas by construction having not less than one-hour fire-resistance.

EXHIBIT 7-2: CONCENTRATION IN AIR AND WATER ABOVE NATURAL BACKGROUND

Element (atomic number)	Isotope ¹		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub³	6×10^{-3}	----------	1×10^{-4}	----------
	A 41	Sub	2×10^{-6}	----------	4×10^{-8}	----------
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	6×10^{-12}	2×10^{-4}	2×10^{-13}	7×10^{-6}
		I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-6}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}

EXHIBIT 7-2: CONTINUED

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air (μc/ml)	Water (μc/ml)	Air (μc/ml)	Water (μc/ml)
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO$_2$)	Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152 (T/2=9.2 hrs)	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152 (T/2=13 yrs)	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}

EXHIBIT 7-2: CONTINUED

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-9}	2×10^{-3}	3×10^{-10}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	----------	4×10^{-5}	----------
Indium (49)	In 113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I 126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}
		I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton[3] (36)	Kr 85m	Sub	6×10^{-6}	----------	1×10^{-7}	----------
	Kr 85	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Kr 87	Sub	1×10^{-6}	----------	2×10^{-8}	----------
	Kr 88	Sub	1×10^{-6}	----------	2×10^{-8}	----------
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}

EXHIBIT 7-2: CONTINUED

Element (atomic number)	Isotope [1]		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Pt 197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu 244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protactinium (91)	Pa 230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	------	1×10^{-8}	------
		I	------	------	------	------
	Rn 222 [3]	S	3×10^{-8}	------	3×10^{-9}	------
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-11}	2×10^{-3}	9×10^{-13}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}

EXHIBIT 7-2: CONTINUED

Element (atomic number)	Isotope [1]		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air (μc/ml)	Water (μc/ml)	Air (μc/ml)	Water (μc/ml)
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	[illegible]$\times10^{-8}$	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	[illegible]	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th 232	S	3×10^{-11}	5×10^{-5}	10^{-12}	2×10^{-6}
		I	3×10^{-11}	10^{-3}	10^{-12}	4×10^{-5}
	Th natural	S	3×10^{-11}	3×10^{-5}	10^{-12}	10^{-6}
		I	3×10^{-11}	3×10^{-4}	10^{-12}	10^{-5}
	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
		I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 234	S[4]	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}

EXHIBIT 7-2 CONTINUED

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 235	S[4]	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U 238	S[4]	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U-natural	S[4]	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
		I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-5}	------------	4×10^{-7}	------------
	Xe 133	Sub	1×10^{-5}	------------	3×10^{-7}	------------
	Xe 133m	Sub	1×10^{-5}	------------	3×10^{-7}	------------
	Xe 135	Sub	4×10^{-6}	------------	1×10^{-7}	------------
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-6}	------------	3×10^{-8}	------------
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.	------------		3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.	------------		6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

EXHIBIT 7-3 ALLOWABLE CONCENTRATIONS ABOVE BACKGROUND

Material	*Microcuries*
Americium-241	.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2 h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

LABELING

NO. 8

METHODS Lecture and Discussion

LENGTH 20 minutes

PURPOSE Provide information on current requirements and recommendations for labeling chemicals.

OBJECTIVES Enable the teacher to ...

1) Identify the types of information that should be given on labels for chemicals.
2) Discuss the problems in getting people to read and follow label directions.
3) Outline a research project for background information about chemicals for labels.

SPECIAL TERMS

MCA labeling recommendations
NFPA labeling recommendations
NIOSH labeling recommendations

INSTRUCTOR MATERIALS

Lesson Plan	Chalkboard, Chalk, Eraser
Slides	Projector (35mm) and Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 8-3

INFORMATION ON LABELS 8-7

INTERPRETING LABELS 8-10

REFERENCES 8-15

EXHIBITS

8-1: Hazard Diagram 8-17

8-2: NFPA Hazard Coding System 8-18

LESSON	NO. 8
NOTES	INSTRUCTION

INTRODUCTION

Proper labeling is one of the fundamental aspects of a safe and effective laboratory operation. Materials that are made in the laboratory, in the course of experiments, require labeling just as much as purchased chemicals that reside on the storeroom shelf.

Labeling has two principal functions. First is adequate identification - what the material is and where it came from. Second is precautionary information for safe handling of all chemicals having significant material hazard.

Purchased reagents always have either the chemical or common name of the material, the name of the manufacturer, and a lot number. If the chemical is flammable, a flash point may be shown on the label accompanied by a precaution regarding fire hazard. If the material is corrosive, toxic, reactive, or unstable, other precautionary information is usually shown. Absence of precautions on the label does not necessarily mean that there is no hazard, since not all manufacturers are diligent in presenting

LESSON NO. 8

NOTES | INSTRUCTION

such information.

Solutions, mixtures, reaction products and other materials generated in the school laboratory should be labeled unless their existence is momentary. Laboratory glassware or bottles containing such materials must be labeled for identification purposes with the name of the material, name of the person who made it, and the date made. If there is any material hazard, an indication of the type of hazard should at least be indicated on the label.

Absence of labels engenders mistakes and can be very dangerous. It is not unusual to walk into a science laboratory and see reagent bottles with no identifying label. Such containers should be discarded immediately upon discovery. Labels sometimes become illegible from chemical contact and if the label cannot be renewed while still readable, disposal is the only answer.

The Federal Hazardous Substances Act, now administered by the Consumer Product Safety Commission, requires precautionary labeling on all flammable, corrosive, reactive, toxic, or radioactive substances intended for non-industrial use.

The U.S. Department of Transportation requires certain shipping labels on packages of hazardous materials carried interstate.

The Occupational Safety and Health Act has a general duty clause requiring an employer to provide a safe place of employment. Unlabeled or inadequately labeled reagents or other materials could be construed to be a violation of this Act.

The National Institute for Occupational Safety and Health has submitted to OSHA a criteria document entitled, "An Identification System for Occupationally Hazardous Materials." Adoption of this or a similar system by OSHA would standardize labeling for industry and for other users of reagent chemicals. This document also recommends use of a Material Safety Data Sheet as a means for manufacturers to transmit hazard information to users.

Liability suits often are based on inadequacy of the label of a material involved in an accident. Good labeling practice would help protect the teacher from such litigation.

In 1944 the Manufacturing Chemists Association, realizing the crucial importance of precautionary labeling, formed its Labels and Precautionary Information Committee and subsequently published six editions of "Guide to Precautionary Labeling of Hazardous Chemicals." The work of this Committee and its publications have been the basis of much current legislation and practice.

LESSON NO. 8

NOTES	INSTRUCTION

INFORMATION ON LABELS

Labels should serve the following functions:

(1) They should show clearly what the material is.

(2) They should show the manufacturer's name and address.

(3) They should indicate the age of the material.

(4) They should indicate possible hazards of the contents and suggest handling precautions.

Material hazards fall into two classes, physical hazards and health hazards. The first are immediately evident and include fire potential, chemical burns, reactivity, and explosion potential. Health hazards are more subtle and sometimes their effects are not evident for a period of time. They relate to inhalation, skin absorption, and ingestion of toxic substances.

The Manufacturing Chemists Association has adopted the philosophy that "Chemicals in any form can be safely stored, handled, or used if the physical, chemical, and hazardous properties are fully understood and the necessary precautions, including the use of proper safeguards and personal protective equipment, are observed." The label should convey the necessary information to promote safe handling.

The NIOSH Criteria Document, "An Identification System for Occupationally Hazardous Materials," recommends that the label contain the following:

(1) The trade name or chemical name of the product;

(2) A hazard symbol consisting of three rectangles containing terse indications of relative health hazard, fire hazard, and reactivity hazard;

(3) Appropriate statements on the nature of the hazard;

(4) Appropriate action statements;

(5) Emergency action and first aid statements;

(6) Clean-up and disposal statements where appropriate.

LESSON NO. 8

NOTES

INSTRUCTION

Exhibit W-8-2 in Workshop W-8 shows the recommended wording for the three blocks in the hazard symbol. The rating numbers should be put in the squares preceding the rectangles of the symbol.

Exhibit W-8-5 and W-8-5a to W-8-5B give directions and statements for use in writing the label.

Exhibit W-8-5i is a sample label appropriate for Prussic Acid, Hydrogen Cyanide.

At times it may not seem practical to put all of the desired information on the label, especially if the container is small. In this case the instructor must use good judgment in selecting the information that should appear on the label. The most essential item is the chemical or product name. A word giving the principal hazard characteristic may be next in importance.

NOTES	INSTRUCTION

INTERPRETING LABELS

Chemical labels are generally self-explanatory. However, existing regulations do not require that all chemical labels contain complete information. Commonly an explanation of the hazard presented by a particular compound is handled by a phrase such as "avoid skin contact," "avoid inhalation," or "keep away from fire, sparks, and open flame." While these statements may apprise the user of the general hazard involved, they do not necessarily indicate the degree of hazard.

Laboratory workers become innured to the phrases "avoid skin contact" and "avoid inhalation of vapor." They are rarely appreciated and routinely ignored. After spending time working in the science laboratories, students may acquire a similar lack of concern for the health hazards presented by chemical reagents. Assigned research into the actual health effects of chemical reagents to be used in laboratory work should be an important part of any

NOTES	INSTRUCTION
	laboratory project. Labels used on mixtures of chemical reagents or solvent mixtures can also be inadequate. Generally only the primary components will be listed. Minor chemical compounds which may actually be more toxic and present a greater danger to the user may be ignored. Instructors who are involved in purchasing chemicals for science laboratory use should make a practice of requesting the material safety data sheet from the supplier or manufacturer of the chemical. The material safety data sheet is a form which most manufacturers will supply and which contains relevant information about the physical and toxicological properties of the chemical. Frequently the material safety data sheet will contain information about minor components or impurities that is lacking on the label. There are no laws or regulations that require a manufacturer or supplier to furnish a material safety data sheet for his or her product. However, most of them will do so.

LESSON	NO. 8
NOTES	**INSTRUCTION**
	A typical material safety data sheet is presented in Exhibit W-8-3 in Workshop W-8. Some chemical labels are now using a diamond shaped diagram as a shorthand method of informing the user of the dangers presented by the particular chemical. Exhibit 8-1 presents a typical diagram. This diagram is based on a hazard identification system proposed in the publication Recommended System for the Identification of the Fire Hazards of Materials published by the National Fire Protection Association (NFPA 704-1975) The diagram is divided into four segments. The top segment indicates the flammability hazard; the left the health hazard; the right the reactivity. The bottom segment is used to identify any special characteristics that the user should be aware of. For example a W with a line through the middle indicates unusual reactivity with water. Oxidizing chemicals are identified by an OXY in the bottom segment and radiation hazards are identified with the radiation symbol.

LESSON	NO. 8
NOTES	INSTRUCTION

The degree of each hazard is indicated by a number in the appropriate segment. The number scale ranges from 0 to 4 with materials designated as 0 presenting little or no hazard in that particular category. Materials with a 4 designation are extreme hazards in the category so designated.

The health hazard designations refer only to the immediate, acute effects of exposure to the chemical. The chronic, long term health effects are not taken into account.

For the health hazard category, the left segment, the numbers have the following meanings.

A 4 indicates that a few whiffs of the gas or vapor or skin contact with a small amount could cause death. Only special protective clothing designed specifically to protect against this particular hazard should be worn by persons entering an area where exposures are likely.

A 3 indicates that the material is extremely hazardous to health, but areas may be

NOTES	INSTRUCTION
	entered with extreme care. Full protective clothing and self-contained breathing equipment must be worn in areas where an exposure is likely. A 2 indicates that the material is hazardous to health, but that areas may be entered freely with a self-contained breathing apparatus. A 1 indicates that the material is only slightly hazardous to health. A 0 indicates that the material presents no greater health hazard under fire conditions than ordinary combustible materials. Exhibit 8-2 presents the explanation of the number scale for flammability and reactivity in addition to health hazard. All chemicals and solvents, especially those with hazard ratings of 2 or higher in any category, should be carefully controlled, well labeled, properly stored, and discretely used. Remember, they can be handled safely if their hazard properties are understood and precautions are heeded.

NOTES	INSTRUCTION
	REFERENCES

REFERENCES

MCA "Guide to Safety in the Chemical Laboratory," Van Nostrand-Reinhold, N.Y., 1972

Steere, N.V.; "Containers and Labeling" in Handbook of Laboratory Safety. N.V. Steere, ed. Chemical Rubber Co., Cleveland, Ohio (1971).

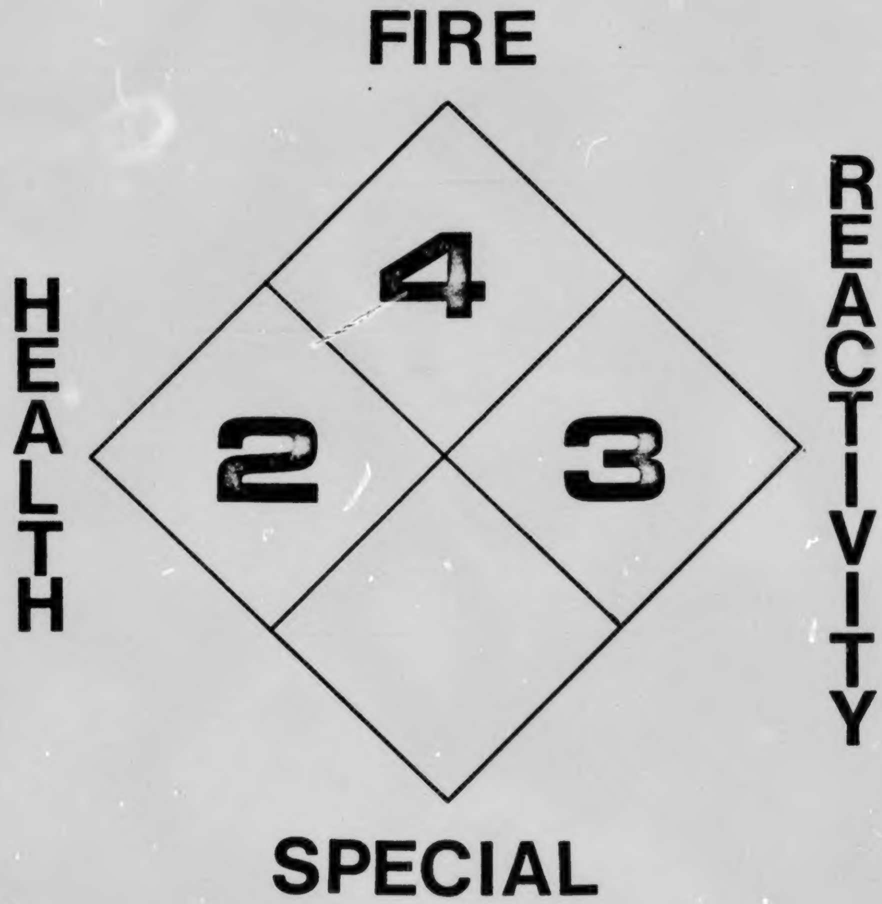
"Guide to Precautionary Labeling of Hazardous Chemicals, Manual L-1," Seventh Edition 1970, Manufacturing Chemists Association, 1825 Connecticut Ave., N.W., Washington, D.C. 20009.

"An Identification System for Occupationally Hazardous Materials, A Recommended Standard," National Institute for Occupational Safety and Health, 1974. HEW Publication No. (NIOSH) 75-126. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

"Recommended System for the Identification of fire Hazards of Materials" NFPA 704-1975, National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

"Federal Hazardous Substances Act Regulations," Code of Federal Regulations 16, Part 1500, 1974, U.S. Government Printing Office, Washington, D.C. 20402.

EXHIBIT 8-1. HAZARD DIAGRAM


FIRE
HEALTH
REACTIVITY
4
2
3
SPECIAL

PAGE 8-18 REMOVED PRIOR TO BEING
SHIPPED TO EDRS FOR FILMING DUE
TO COPYRIGHT RESTRICTIONS

HANDLING GLASSWARE

NO. 9

THODS Lecture and Discussion **LENGTH** 30 minutes

POSE

Emphasize the need for establishing proper procedures for handling, storing, and disposing of glassware in the laboratory.

ECTIVES

Enable the teacher to....

1) List 5 recommendations for the safe storage of laboratory glassware.

2) Discuss factors to consider in selecting glassware for the school science laboratory.

3) Use proper procedures for cleaning, cutting, and disposing laboratory glassware, as well as other handling techniques.

CIAL
MS

Borosilicate glass
Contaminant-free glass
Soda-lime glass

TRUCTOR
ERIALS

Lesson Plan
Slides

Chalkboard, Chalk, Eraser
Projector (35mm) and Screen

INEE
ERIALS

Note-taking

CONTENTS

INTRODUCTION 9-3

RECEIVING AND STORAGE 9-4

SELECTION OF GLASSWARE 9-5

    Types of Glass 9-6

    Corrosion Resistance 9-6

    Thickness 9-7

    Special Precautions 9-7

GLASSWARE MANIPULATION 9-8

    Cutting of Glassware 9-8

    Insertion in Tubing and Stoppers 9-9

    Cleaning of Glassware 9-10

    Disposal of Glassware 9-12

REFERENCES 9-13

LESSON NO. 9

NOTES	INSTRUCTION
Material of construction Disadvantages of glass	INTRODUCTION One of the most common materials of construction in the high school science laboratory as well as any type of science laboratory is glass. The great majority of containers used in science laboratories are made of glass. Glass is an excellent material of construction because it is relatively inexpensive, highly resistant to chemical attack, easily cleaned. and non-contaminating. Glass has one big major disadvantage that counterbalances all of its advantages in the science laboratory. It breaks very easily. When it breaks, it produces extremely sharp edges and points which readily cut human tissue.

NOTES | INSTRUCTION

RECEIVING AND STORAGE

Like any fragile equipment, glassware should be carefully handled upon receipt. Broken glass is frequently found in containers being unpacked. Instructors and students alike should assume that broken glass may be present when shipping cartons are being opened.

Cracked pieces

Upon receipt each carton of glassware should be opened and the glass items examined for cracked or nicked pieces. These pieces, if not replaced, may fail during use at some later date.

Storage

Special attention should be paid to the storage of glassware. Glassware should be stored in a well-lighted area on shelves designed for this purpose. The edges of the shelves should have a rim of sufficient height to prevent the glass pieces from falling off the shelf. The following recommendations, if implemented, will provide a safe glass storage area.

Recommendations

(1) Light pieces of glassware should be stored on upper shelves and heavy pieces on

lower shelves.

(2) Tall pieces of glassware should be stored at the back of the shelf and short pieces near the front.

(3) Glass pieces on the highest shelf should be reachable by all parties without resorting to a stepladder or stool.

MCA (1972)

(4) Glass rods and tubing should be stored in a horizontal position, and no piece should protrude over the edge of the shelf.

(5) All aisles in the storage area should be kept clear of obstacles and debris at all times.

SELECTION OF GLASSWARE

There are many factors to consider when selecting glassware for laboratory needs. Some of these are:

(1) The purpose of the glassware;

(2) The quality of glass required;

(3) The cost.

Glassware is not all composed of a homogeneous type of glass. There are different types of glass with different physical and chemical properties. There are thin, inexpensive soda-lime glasses which can be thrown away after a single use, and there are expensive, pure silicon dioxide glasses for corrosive, high-temperature applications.

Types of Glass

Soda-lime glass

Borosilicate glass

There are many different types of glass. They are differentiated by their chemical composition and thermal treatment. In the high school science laboratory there are two glasses that are important: Soda-lime glass and borosilicate glass. A typical soda-lime composition is silica - 72%, soda - 15%, magnesia - 10%, alumina - 2%, and miscellaneous oxides - 1%. Borosilicate glass is formed by the addition of boron oxide (B_2O_3) to a soda-lime mixture. The glass thus formed has excellent chemical and heat resistance. The common laboratory glasses - Pyrex and Kimax - are borosilicate glasses.

Corrosion Resistance

Silicate glasses are affected to some

Glass-corroding reagents

degree by most laboratory solutions. The following glass-corroding reagents are listed in decreasing order of effectiveness: hydrofluoric acid, sodium hydroxide, sodium carbonate, ammonium hydroxide, phosphoric acid, and sulfuric acid. Hydrofluoric acid and hot phosphoric acid are so corrosive to glass that they should never be put in glass containers.

Thickness

Glass apparatus comes in varying thicknesses for various purposes. Where thicker glass is required, in vacuum and pressure applications, it should be used.

Special Precautions

Failure of glass

Smith (1971)

Earlier, it was mentioned that incoming glassware should be inspected for scratches and nicks. The failure of glassware is almost always initiated at the surface of the glass. Localized impacts from sharp objects, scratches, and localized heating can all put extremely high local stresses on a glass surface. Total failure can quickly occur at one of these high stress locations. Glassware that reveals surface nicks and scratches under visual observation should be removed from service.

GLASSWARE MANIPULATION

Cutting of Glassware

Personal protection

Cutting techniques

Nearly all glassware cutting in school science laboratories involves glass rods or tubing. Tubing and rods are readily cut by making a straight, clear mark on the glass surface at the place where the glass is to be cut. The individual doing the cutting should be wearing leather gloves and eye protection. The rod or tube is grasped in both hands, one on each side of the score mark, and the thumbs are extended and placed against the glass tubing or rod opposite the score mark. The rod or tubing should be bent toward the body thus putting the scored surface in tension. The rod or tubing should break cleanly at the score mark. The cut ends should be fire polished to eliminate

LESSON **NO. 9**

NOTES	INSTRUCTION
	any sharp edges.
	Cutting glass tubing and rod is basically a very simple but very dangerous procedure. The hands must be protected very well if injuries are to be avoided.
	Insertion in Tubing and Stoppers
	It is very easy to break glass tubing or rods when inserting it into a hole bored into a rubber or cork stopper. Before any tubing is inserted, care must be taken to ensure that the hole in the stopper is bored to the correct size. Glass tubing will not penetrate a stopper just because the stopper has a hole in it. The diameter of the hole should be slightly smaller than the diameter of the glass rod or tubing. If there is a large size disparity, excessive force may be necessary to force the glass piece through the stopper. When excessive force is used is when trouble is highly likely to occur.
Lubrication of tubing	Glass tubing should be lubricated with water or glycerine before insertion into the rubber stopper. The individual doing the

NOTES	INSTRUCTION
	insertion should always wear gloves, preferably leather gloves. All forces used to insert the tubing should be directed along the axis of the tubing. Glass tubing or rods should never be subjected to bending or flexing forces while being inserted into a stopper. When inserting glass tubing into rubber or plastic tubing, many of the precautions discussed above should be observed. The glass should be lubricated before insertion into the rubber or plastic tubing. The rubber tubing should be cut at an angle before the insertion of the glass piece. The angled cut allows the rubber to stretch more readily. Cleaning of Glassware For most high school science experiments, laboratory glassware can be effectively cleaned by using any one of a number of laboratory detergents available for that purpose. Glassware that is not contaminated with a hard-to-remove residue can be soaked in a detergent-water solution, rinsed with tap water and distilled water, and then air dried. It

may be necessary to rinse glassware cleaned in this manner with a dilute acid rinse to remove all of the detergent from the surface of the glass.

If totally contaminant-free glassware is required, acid cleaning of the glassware may be necessary to remove all trace contaminants from the glass surface. Glassware which is to be acid-cleaned is first washed with a detergent solution as was discussed above. The glassware is then soaked in a solution of sodium dichromate and sulfuric acid. The soaking period may vary depending on the exact purpose for which the glassware will be used. After the completion of the soaking step, the glassware is rinsed with tap water and distilled water, and allowed to air dry.

Other acids, concentrated nitric and concentrated hydrochloric, can be used to replace or supplement the sodium dichromate-sulfuric acid cleaner where necessary. The instructor must realize that the acid cleaning procedure can be extremely dangerous to the

NOTES	INSTRUCTION
	students and to the building fixtures.
Personal protection	Students using this procedure must wear the full complement of required personal protection: safety goggles, face shield, rubber gloves, rubber apron, and lab coat. They must use extreme care to avoid splashing themselves or others with concentrated acids. They must not discharge excessive quantities of concentrated acid into the sink drain without taking the proper precautions. Any acid flushed down the drain should be diluted with copious quantities of water.
	Disposal of Glassware
	Broken glass should be disposed of in a specially marked container set aside for that purpose. It should not be disposed of in the normal trash receptacles, as janitors and cleaning personnel can be injured by broken glass in unmarked containers. When breakage occurs the large glass pieces can be removed by sweeping with a wisk broom into a dust pan. The small particles are then removed by wiping the entire area with wet cotton swabs.

REFERENCES

Manufacturing Chemists Association: Guide for Safety in the Chemical Laboratory, 2nd edition. Van Nostrand Reinhold Company, New York (1972).

Smith, G.P.: Glass in Handbook of Laboratory Safety. N.V. Steere, ed. The Chemical Rubber Co., Cleveland, Ohio (1971).

BIOLOGICAL AND ANIMAL HAZARDS

NO. 10

METHODS Lecture and Slides

LENGTH 30 Minutes

PURPOSE

To provide an overview of desirable safety and health practices in science laboratories that perform biological studies

OBJECTIVES

Enable the instructor to --

1) Recognize sources of hazards in the biological laboratory
2) Develop evaluation (measurement) techniques for microbiological hazards
3) Design safety and health program designed to minimize these hazards

SPECIAL TERMS

Microorganisms
Pipet
Syringes
Inoculating loops
Embryomated
Pathogenic

INSTRUCTOR MATERIALS

Lesson Plan

35 mm slides

Projector (35mm) and Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 10-3

OCCURRENCES RESULTING IN ACCIDENTAL INFECTION 10-4

INFECTIOUS AGENTS 10-7

EVALUATION OF MICROBIOLOGICAL HAZARDS 10-8

PROPER LABORATORY PROCEDURES 10-9

- General Precautions 10-9
- Specific Laboratory Procedures 10-10
- Pipetting 10-10
- Syringes 10-11
- Inoculating Loops 10-12
- Centrifuging 10-13
- Handling Embroyonated Eggs 10-14
- Safety Cabinets 10-15
- Signs 10-15
- Blood Letting Experiments 10-16
- Miscellaneous 10-17

ANIMAL CARE AND HANDLING 10-19

REFERENCES 10-21

EXHIBITS

- 10-1: Microorganisms and the Diseases they Cause 10-22
- 10-2: Biohazard Sign 10-23

LESSON NO. 10

NOTES	INSTRUCTION
Phillips (1971)	INTRODUCTION As early as 1893, cases of laboratory acquired infections occurring in research labs were recorded. Cases still routinely appear today in the scientific literature. Microorganisms, like toxic chemicals, are a definite hazard to persons performing biologic experiments. Working with them requires special handling techniques and may require specialized laboratory equipment. Instructors must be aware of the hazard presented by infectious agents and the possible sources of infection present in the laboratory. Biological experimentation offers a unique and interesting learning experience for the student, and when properly conducted can be very informing and exciting.

OCCURRENCES RESULTING IN ACCIDENTAL INFECTION

In approximately 80 percent of all laboratory-acquired infections, the cause is unknown. It requires such a minor mishap to release pathogenic microorganisms into the air that pinning down the exact time and operation responsible may be impossible. In the 20 percent of laboratory infection cases for which the causes are known, there are five causes which appeared most frequently. These are:

(1) Oral aspiration through pipettes;

(2) Accidental syringe inoculation;

(3) Animal bites;

(4) Spray from syringes;

(5) Centrifuge accidents.

Phillips (1971)

Other common cuases of laboratory-acquired infections are cuts or scratches from comtaminated glassware, cuts from animal autopsy instruments, and the spilling or dropping of pathogenic cultures on floors or table tops.

Laboratory aerosols which enter the body through the respiratory tract are known to be

NOTES	INSTRUCTION
	sources of infection. Spray from syringes, centrifuge accidents, a film of culture breaking on an inoculating loop, and a surface bubble breaking when a culture is stirred all give rise to aerosols which can readily enter the body. Another common source of infection by microorganisms is contact with laboratory animals. Laboratory animals transmit pathogenic microorganisms to humans by bites, scratches, generation of aerosols, contact with the animal, and contact with a contaminated cage or bedding. This information is presented to form a basis for proper handling of pathogenic organisms. It is strongly recommended that pathogenic organisms not be introduced into a school science laboratory experiment. It is recommended that only sterile biologic fluids and non pathogenic microorganisms be obtained from reputable scientific supply houses. If laboratory animals are to be used, they should be obtained through licensed experimental animal suppliers and should be housed and

NOTES	INSTRUCTION
	cared for so that they will not acquire infection during experimentation.

LESSON NO. 10

NOTES	INSTRUCTION

INFECTIOUS AGENTS

Nearly all groups of microorganisms have some effect on man. Exhibit 10 - 1 presents the various groups of microorganisms and some of the diseases in man for which each group is responsible.

Each group listed is responsible for many more diseases than the few listed. There is no group of microroganisms that does not contain some pathogenic members. Consequently experimentation which may involve microorganisms either directly or indirectly must be strictly controlled.

LESSON	NO. 10
NOTES	INSTRUCTION

EVALUATION OF MICROBIOLOGICAL HAZARDS

Like other aerosols, microorganisms can be collected from the air through the use of a number of air sampling procedures. Microorganisms can be collected by impingement in liquids, impaction on solid surfaces, filtration, sedimentation, centrifugation, and electrostatis precipitation. They must then be cultured in traditional fashion for identification and quantification.

LESSON NO. 10

NOTES

INSTRUCTION

PROPER LABORATORY PROCEDURES

General Precautions

The same general precautions that are required in any science laboratory using hazardous chemical compounds are required in any laboratory in which microorganisms are studied or used. The following precautions must be observed.

(1) No food or drink should be stored, taken into, or consumed in the laboratory;

(2) Only authorized employees or students should be allowed in the laboratory;

(3) Students and instructors should wash their hands thoroughly before leaving the laboratory;

(4) Smoking should not be permitted in the laboratory;

(5) Extraneous items such as books, coats, and umbrellas should be left outside the laboratory;

(6) Protective clothing should be worn where necessary, and should be carefully disposed of.

LESSON NO. 10

NOTES	INSTRUCTION

These general precautions are designed to minimize the possibility of accidental infection of both the laboratory personnel and of any outsiders who come in contact with them.

Specific Laboratory Procedures

A number of specific laboratory operations which deserve special attention when microorganisms are involved will be covered below.

Pipetting

The greatest hazards of pipetting are (1) the production of aerosols, (2) accidental ingestion of fluid, and (3) contamination of the mouthpiece. Hazards (2) and (3) can be remedied by using a pipetting bulb or other device available. The mouth then does not have to be anywhere near the pipet. If one of these devices is not available, the pipet should be plugged with cotton between the liquid level and the mouthpiece. Plugging the pipet with cotton is recommended even if a pipetting device is used.

Pipets should be handled carefully to minimize the hazard of aerosol generation. The pipet should never be used to bubble air through a contaminated liquid. Liquid should never be forcefully blown out of the pipet. The pipet should always be discharged, if possible, with the tip below the surface of the receiving liquid. Immediately after use contaminated pipets should be immersed in a germicidal solution, and then autoclaved before reuse.

Syringes

The hazards which are common to syringe use are (1) accidental inoculation, and (2) aerosol production.

Accidental inoculation must be carefully guarded against. If animals are to be inoculated care must be taken to restrain the animals and prevent them from bumping the syringe.

Only syringes with locking needles should be used for work with pathogenic organisms. If a non-locking needle should happen to come off, a very hazardous aerosol can be generated.

Ideally, disposable syringes with a permanently affixed needle should be used. Excess liquid or air bubbles should be expelled vertically from a syringe into a piece of cotton moistened with a disinfectant. A syringe should never be used for mixing liquids by forcefully expelling a liquid from the syringe into another liquid. When a syringe is used to transfer one liquid to another, the tip of the syringe should always be placed below the surface of the receiving liquid before a liquid is discharged. After use, syringes should be placed in a container of disinfectant and then autoclaved.

Students and instructors must take great care when manipulating syringes. The hand should never touch the needle and hub or the shaft of the plunger. These areas are often contaminated in normal use.

Inoculating Loops

Inoculating loops must be used with care. The film held by a loop may break and cause substantial atmospheric contamination. A hot loop may cause a liquid to spatter when it is inserted into it. When a contaminated loop is inserted into a flame for sterilization, an aerosol may be generated by boiling and volatilization of the material before the flame can kill all pathogenic microorganisms.

Liquid cultures should never be agitated by inoculating loops because of the possible production of aerosols. Loops should be allowed to cool before insertion into liquids. This may require the use of more than one loop so that as one is being used others are cooling.

Whenever inoculating loops are being used, any actions that might result in the generation of an aerosol - jerky movements, shaking of the loop, agitating liquids - must be avoided.

Centrifuging

Centrifuges are commonly used in science laboratories to separate cellular material from the suspending liquid medium. If the cellular material consists of pathogenic microorganisms,

NOTES	INSTRUCTION

exceptional care must be taken with all phases of the operation.

Glass tubes used to hold cultures may break in the centrifuge. This may result in large numbers of microorganisms being spread throughout a laboratory. All glass tubes used in the centrifuge should be carefully inspected for cracks and flaws before use. The inside of the metal centrifuge cup should be inspected for roughness also before use. One way of minimizing the effects of tube breakage is to fill the space between the glass tube and the metal cup with a germicidal solution. If a tube does break, the germicidal solution will tend to nullify the effects of the breakage.

Handling Embryonated Eggs

Eggs that are infected with viruses can be extremely dangerous. The inoculation procedure itself can generate a hazardous aerosol in many ways. The infected egg contains an extremely concentrated virus population. The egg shell provides little protection and is readily breached. Infected eggs should be handled only in a ventilated safety cabinet.

Safety Cabinets

Microbiological safety cabinets are specially designed fume hoods for use with pathogenic microorganisms. They may be designed with a small open work area or with a totally enclosed work area. Air velocity across the open face should be greater than or equal to 200 feet per minute. All air exhausted through these cabinets must pass through an absolute filter before it is emitted to the atmosphere. It is recommended that all operations involving pathogenic organisms be performed in a safety cabinet.

Signs

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor requires the posting of a biological hazard warning sign to "signify the actual or potential

20 CFR 1910.145(j)

NOTES	INSTRUCTION
	presence of a biohazard and to identify equipment, containers, rooms, materials, experimental animals, or combinations thereof, which contain or are contaminated with, viable hazardous agents." The term "biohazard" is defined as meaning only those infectious agents which present a risk or potential risk to the well-being of man. Exhibit 10-2 presents the recommended biohazard warning sign. The symbol design must be colored a fluorescent orange or orange-red color. The background color is optional as long as it presents sufficient contrast to the symbol. Blood Letting Experiments Experiments involving observation of human blood cells or blood typing necessarily require a source of human blood. Blood letting experiments can be very safely conducted if the following rules are followed. (1) Conduct the blood letting experiment in a neat, clean and sanitary facility. (2) Only the instructor should perform the

puncturing of the student's finger.

(3) Cleanse the area to be punctured with soap and water and rinse well. Then cleanse with 70% isopropyl alcohol and dry with sterile cotton or gauze pads.

(4) Puncture finger with sterile, disposable lancet.

(5) Hold finger over a clean microscope slide and let blood drip onto slide making sure there is no contact of the two.

(6) Cleanse finger with alcohol again upon completion of sample collection.

(7) Hold sterile gauze or cotton on area until bleeding stops or about 3-5 minutes.

If these few suggestions are followed, a safe and healthy lab experiment can be conducted.

Miscellaneous

When tubes containing cultures are agitated, care should be taken to avoid contaminating the tube caps or cotton plugs. If the closure is contaminated, an aerosol can be generated when the cap or plug is removed.

LESSON **NO.** 10

NOTES | **INSTRUCTION**

Care should be taken in handling culture tubes and petri dishes that are stored in incubators, refrigerators, and freezers. Broken tubes or dishes in any of these storage devices can result in rapid dissemination of infectious aerosols. It is a good practice, if possible, to place glass culture containers in a secondary, unbreakable container.

If pathogenic microorganisms are going to be used in a school science laboratory, there must be some facility for sterilizing or disinfecting laboratory equipment. All material used must be sterilized even if it is going to be disposed of. Sterilization and disinfection procedures are recommended even with non pathogenic organisms. Heat is considered to be the most effective sterilizing agent. Some gases can be used for sterilization purposes, but they require careful handling and may present dangers themselves. Liquid disinfectants or germicidal agents generally have limited effectiveness and should not be relied on for complete sterilization.

Everett (1975)

LESSON NO. 10

NOTES

INSTRUCTION

ANIMAL CARE AND HANDLING

All animals used in experimental research should be treated in a humane fashion. The animal care facilities should be kept clean, vermin should be controlled, wastes must be removed, and the concentration of pathogenic microorganisms kept to a minimum.

Animals can contract diseases from human beings. Such diseases as salmonellosis, influenza, tuberculosis, and infectious hepatitis can all be transmitted from man to animals. Anyone working with experimental animals must stay away from them if they are infected with any disease-causing microorganisms.

Conversely human beings can contract numerous diseases from infected animals. Infected animals can transmit disease to healthy animals. Any animal suspected of being ill should be isolated from other animals.

Animals should be handled very carefully. Students and instructors should never place their bare hands in an animal cage. Gloves should always be worn when handling animals. Cages

NOTES	INSTRUCTION
	should be sterilized before and after placing animals in them. All feeding devices and bedding materials must be sterilized as well. Access to animal care facilities must be strictly limited to those individuals directly concerned with their care.

NOTES	INSTRUCTION

REFERENCES

Allen, R.W.; Ells, M.D.; and A. Hart: *Industrial Hygiene*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1976).

Everett, K. and D. Hughes: *A Guide to Laboratory Design*. Butterworths, 161 Ash Street, Boston, Massachusetts (1975).

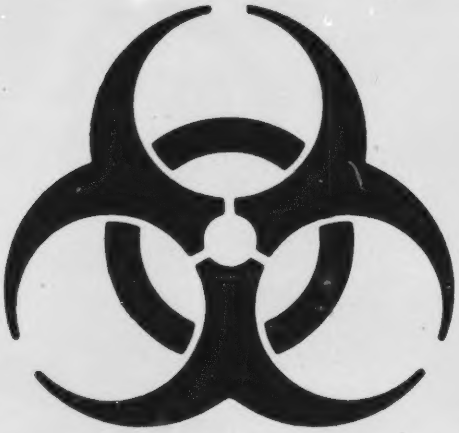
Phillips, G.B.: "Prevention of Laboratory Acquired Infections" in *Handbook of Laboratory Safety, 2nd Ed*. N.V. Steere, ed. The Chemical Rubber Company, Cleveland, Ohio (1971).

EXHIBIT 10-1: MICROORGANISMS AND THE DISEASES THEY CAUSE

Microorganism	Human Disease
Bacteria	Diptheria
	Tuberculosis
	Rheumatic Fever
	Pneumonia
Viruses	Chicken Pox
	Measles
	Mumps
	Poliomyelitis
Fungi	Athlete's Foot
	Systemic Mycosis
Rickettsiae	Typhus
	Q Fever
	Rocky Mountain Spotted Fever
Protozoa	Schistosomiasis
	Malaria
	Giardiasis

EXHIBIT 10-2: BIOHAZARD SIGN

CAUTION



BIOLOGICAL HAZARD

Visitors and Personnel not Assigned to this Area Contact:

____

Ext: ____________ Before Entering.

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

VENTILATION

NO. 11

METHODS Lecture and Discussion

LENGTH 30 Minutes

PURPOSE

Provide background information on the characteristics, requirements, and testing of laboratory ventilation.

OBJECTIVES

Enable the teacher to ...

1) Specify the characteristics and requirements of his/her laboratory ventilation systems.
2) Perform calculations on atmospheric concentrations of airborne contaminants.
3) Recommend needed improvements in laboratory ventilation to school administrators.

SPECIAL TERMS

- Dilution ventilation
- Exhaust ventilation
- Face velocity
- Permissible Airborne Concentration (PAC)
- Smoke tube
- Threshold Limit Value (TLV)
- Time-Weighted Average (TWA)
- Velometer

INSTRUCTOR MATERIALS

- Lesson Plan
- Slides
- Chalkboard, Chalk, Eraser
- Projector (35mm) and Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 11-1

INDUSTRIAL REQUIREMENTS 11-5

SAFETY PROBLEMS 11-7

  Chemical Storage 11-7

  Hood Placement 11-8

  Restriction of Air Flow 11-8

  Commercial Hoods 11-9

  Laboratory Operations 11-10

HEALTH PROBLEMS 11-11

  Threshold Limit Value Concept 11-11

  Calculations 11-12

PROPER HOOD OPERATION 11-15

  Face Velocity Requirements 11-15

  Air Supply Requirements 11-15

  Materials of Construction 11-16

TESTING OF HOODS AND VENTILATION SYSTEMS 11-19

  Swinging Vane Anemometer 11-19

LOCAL INSTRUMENT EXHAUST SYSTEM 11-21

RECIRCULATION OF LABORATORY ATMOSPHERES 11-22

GENERAL PURPOSE SCIENCE ROOM VENTILATION 11-23

REFERENCES. 11-25

EXHIBIT 11-1 11-26

NOTES

INSTRUCTION

INTRODUCTION

The installation of effective and adequate ventilation systems for secondary school science laboratories should be at the top of the list when new school laboratories are constructed or old laboratories are remodeled.

Science laboratory ventilation systems have two major components:

(1) A system of laboratory hoods which provides a specified number of volume changes for a relatively small volume of space;

(2) The general heating and cooling system which conditions the room air and may provide a specified number of volume changes for the room or building.

If the school building does not have a forced air heating system, a third ventilation component system, a make-up air system, might be necessary. Exhaust hoods remove air from buildings. The air should be replaced at a rate equal to or slightly less than the rate at

NOTES	INSTRUCTION

which it is removed. This is the function of the make-up air system.

The function of a laboratory hood system is to capture, contain, and expel any emissions generated by any operation carried out in the hoods.

The function of the heating and or cooling system is to serve as a general dilution system and a make-up air system. This system must provide enough room atmosphere changes to dilute the atmospheric concentrations of hazardous materials in the room to a safe level.

NOTES	INSTRUCTION
	INDUSTRIAL REQUIREMENTS
Face velocity	The one parameter of hood operation that is most commonly used to evaluate the performance of the hood is the face velocity. The face velocity of the hood is the average velocity of the air in feet per minute (fpm) in a direction perperndicular to the plane of the hood opening.
	The following organizations specify face velocities for laboratory fume hoods:
Committee on Industrial Ventilation (1974)	(1) American Conference of Governmental Industrial Hygienists
29 C.F.R. 1910.1003	(2) U.S. Occupational Safety and Health Administration
ANSI, (1971)	(3) American National Standards Institute
Steere, (1974)	(4) American Chemical Society
29 C.F.R. 1910.1000	(5) National Institute for Occupational Safety and Health
	Exhibit 11-1 contains a list of the recommending organizations together with their recommendations. The required hood face velocity will vary between 100 and 150 feet per minute depending on whether the hood is used for routine operations or hazardous operations.

LESSON NO. 11

NOTES	INSTRUCTION
Definition of routine operations The TLV (Threshold Limit Value) concept is discussed later in the section on Health Problems.	Routine operations are those which involve the use of low toxicity materials; e.g., ethanol, or small quantities of moderately toxic materials; e.g., ethyl acetate, ethyl ether. Low toxicity materials are those with a TLV (TWA) greater than or equal to 500 ppm. Moderately toxic materials are those with a TLV between 100 and 500 ppm.
Definition of hazardous operations	Hazardous operations are those which involve the use of large quantities of moderately toxic materials or any quantity of highly toxic material; e.g., any material with a time-weighted average exposure limit to 100 parts per million or less, any carcinogen, or any pathogenic microorganism.

NOTES

INSTRUCTION

SAFETY PROBLEMS

designs

In conjunction with the current interest in health and safety problems originating from chemical compound exposures, there has been an upsurge in interest in the proper design and construction of fume hoods. Specific hood designs are available for many different types of hood use - corrosive materials, flammable materials, explosive materials. Health and Safety problems originate when a particular hood is misused.

misuse

Misuse can occur when a hood is used for a purpose for which it was not designed, when it is placed in the wrong position in a laboratory, or when it's air flow is unknowingly restricted.

Chemical Storage

A typical example of hood misuse is the storage of toxic and flammable chemical reagents in fume hoods. Fume hoods do not provide security, or protection against fire. In schools they are normally shut off at the end of the

LESSON NO. 11

NOTES | INSTRUCTION

class, and this does not provide 24-hour per day, seven day per week vapor removal.

Hood Placement

Hood efficiency

Hood efficiency is also dependent on placement in the laboratory. If the hood is located close to a door, drafts will often cause serious problems with the airflow patterns in the hoods. Even the disturbances in air flow patterns resulting from people walking past the front of the fume hood can reduce the efficiency of the hood.

Restriction of Air Flow

If the air supply of a hood is restricted, it will not perform up to design specifications. An air flow restriction can occur when the make-up air supply is not sufficient, when the motor performance drops, or when the air ducts become partially plugged or corroded.

If the make-up air supplied to the laboratory does not equal the design air flow through the hood, the air flow through the hood will be reduced.

Decreases in motor performance occur as a result of slipping belts or voltage drops in the electrical supply. If the motor is operating at fewer revolutions per minute, the quantity of air exhausted by the fan will be reduced.

Other sources of poor hood performance are plugged ductwork and corroded ductwork that has leaks in it. Horizontal duct runs are susceptible to plugging by dirt and dust. They should be inspected and cleaned regularly. The dirt cuts down the cross-sectional area of the duct and reduces the air flow. Ducts which have holes from corrosive acids will allow the infiltration of large quantities of air which reduces the quantity of air pulled through the hood. Corroded ductwork should be replaced immediately.

Commercial Hoods

There are commercial hoods available for general laboratory use, for use with flammable solvents and gases, for use with perchloric acid, for use with biological materials, and for

NOTES | INSTRUCTION

highly corrosive materials.

Whoever has the responsibility for purchasing fume hoods must evaluate the needs of the particular laboratory which requires the hood. Substantial costs can be saved by purchasing the least expensive hood which will do the job while providing adequate safety and health protection.

Laboratory Operations

Laboratory operations should be carried out in hoods known to be capable of handling that particular operation. Highly flammable solvents should be used only in hoods that contain explosion-proof electrical fixtures and non-sparking fans and motors. Perchloric acid should be used only in hoods constructed of appropriate materials and containing a washdown system. It is the responsibility of the instructor to determine the capabilities of the particular hood(s) with which his laboratory is equipped. Misuse of a hood can result in severe injuries to personnel and extensive damage to property.

HEALTH PROBLEMS

School instructors have always been aware of the common laboratory safety hazards. A safety incident nearly always results in a rapid, traumatic, personnel injury or in substantial, visible property damage. Health problems are more insidious. They are frequently of a chronic nature and may not become apparent until long after the exposed individual has left the vicinity of the exposure.

Threshold Limit Value Concept

ACGIH (1976)

In an attempt to provide realistic chemical exposure guidelines, the American Conference of Governmental Industrial Hygienists (ACGIH) publishes a booklet which is updated annually and which contains allowable atmospheric concentrations of many chemical compounds. The booklet is entitled "TLVs, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment." A threshold limit value (TLV) is an atmospheric concentration which represents the maximum average atmospheric

NOTES	INSTRUCTION
	concentration to which a worker may be exposed over a normal eight-hour day, forty-hour week work cycle.
OSHA permissible exposure limits	Many of the ACGIH TLVs have been incorporated into the permissible exposure limits (PEL) contained in the OSHA regulations. The proper interpretation of the TLVs or PELs is a highly technical endeavor and actually requires a separate course in itself. In those school systems which are amenable to the OSHA regulations, knowledge of the PELS and their interpretation may be essential to the operation of a safe and litigation-free laboratory operation.
TLV calculations	Calculations TLVs or PELs are numerical concentration values expressed in parts per million (ppm) and/or milligrams per cubic meter (mg/m^3). Atmospheric concentration values are determined empirically by sampling known quantities of air and analyzing the samples. Most TLVs and PELs are time-weighted average (TWA) values. Very rarely is a single individual ever exposed to a completely uniform

atmosphere. The concentrations of airborne materials fluctuate unpredictably, and the time weighted average approach is used to determine the average concentration an individual is exposed to over a given period of time. Since the TLVs and PELs are designed for workers, the time base for TWA calculations is eight hours.

This concept is best explained by a sample calculation. If an individual is exposed to 50 ppm xylene for one hour, 200 ppm xylene for three hours, and 250 ppm xylene for four hours, the TWA would be calculated according to the following formula:

$$TWA = \frac{C_aT_a + C_bT_b + ..+C_nT_n}{8}$$

where C_n = Concentration of material

T_n = Time, in hours, or exposure to C_n.

For the case described above, the TWA would be calculated in the following fashion:

$$TWA = \frac{50(1) + 200(3) + 250(4)}{8}$$

$$= 206.2 \text{ ppm}$$

This is well over the TLV of 100 ppm.

Generally, school science laboratories do not possess the sophisticated equipment necessary for the sampling and analysis of atmospheres. Instructors can calculate atmospheric concentrations for volatile solvents if they can estimate the amount evaporated, by using the following formula:

$$C = \frac{24.5x10^6\ (V_L)(\mu L)}{V_R\ (MW)}$$

where C = Concentration of solvent in room air in parts per million

V_L= Volume of liquid solvent evaporated in millimeters

μL = Density of liquid solvent in grams per millimeter

V_R = Volume of room in liters

MW = Molecular weight of solvent in grams

LESSON NO. 11

NOTES	INSTRUCTION
	PROPER HOOD OPERATION
	Effective hood operation is not merely a function of installing a large enough fan to pull air through the system. Many other factors must be taken into consideration.
	Face Velocity Requirements
Face velocity requirements	The face velocity requirements for the two use classes, routine and hazardous, were discussed above. Face velocities are extremely important. Failure to maintain the required face velocities may result in the diffusion of hazardous chemical compounds back into the laboratory atmosphere.
	Air Supply Requirements
	One key factor in hood operation that is frequently overlooked is that any air exhausted from a room must be replaced. This air that must be supplied is called make-up air. The method of supplying make-up air will control, to a certain extent, the efficiency of the hood operation.

NOTES	INSTRUCTION
	One method of air replacement is infiltration into the room containing the hood through open windows and doors. If the doors and windows are closed, the air must come in through any available opening. This can result in doors being difficult to open, and a loss of hood efficiency. If the school laboratory contains several hoods, a make-up air supply should be provided for the room.
	Many hoods are designed to supply part of the air which sweeps the interior of the hood directly from the outside. These hoods are often called make-up air hoods. By reducing the amount of tempered (heated or cooled) air that is withdrawn from the laboratory room, make-up air hoods conserve energy.
Fume hood placement	Fume hoods are also very susceptible to placement in the laboratory. This concept was discussed earlier.
	Materials of Construction
	Hood interiors are commonly constructed of plastic materials, stainless steel or asbestos

NOTES	INSTRUCTION
	sheet. All these materials have their good and bad points. The plastic materials are easy to clean and relatively inexpensive, but they are subject to attack from a variety of chemicals. The stainless steel hoods are extremely expensive and are also subject to attack by a number of chemicals. The asbestos sheet is resistant to most chemicals, but it is very difficult to keep clean.
Perchloric acid use	Certain laboratory operations require the use of special hoods. Perhaps the most common operation which requires a special hood is the use of perchloric acid for the dissolution of organic or inorganic materials. Perchloric acid forms explosive perchlorates upon dehydration. It should never be used in any hood that is not constructed of essentially seamless stainless steel. The hood must also be equipped with wash down facilities. It is unlikely that these facilities would ever be needed in school laboratories, but all science teachers should be aware of the need for specialized facilities for use with certain chemical reagents or products.

NOTES	INSTRUCTION
Exotic coatings	Hoods are also being supplied by various manufacturers with different types of more exotic coatings. These specialized coatings increase cost without necessarily increasing hood performance or safety. The best source of information on these materials is the manufacturer himself.

NOTES	INSTRUCTION
Testing of ventilation systems	TESTING OF HOODS AND VENTILATION SYSTEMS The testing of hoods and ventilation systems can be a very complex business. In the preceeding sections, some of the face velocity requirements for laboratory hoods were discussed, as well as the importance of maintaining these recommended velocity values over the life of the hood. As hood systems age, face velocities may undergo drastic changes. Ductwork corrodes, fan blades bend and break, and ducts clog. All of these phenomena have the effect of reducing face velocity in the hoods. Frequently new hoods are added to an existing system, but the fan capacity is not increased. The fan still exhausts the same volume of air, but now must do so through more openings. This results in a decreased flow and face velocity through each opening. Swinging Vane Anemometer
Measurement of face velocities	Face velocities in hoods are commonly measured with a swinging vane anemometer commonly

Velometers

known as a velometer. The velometer translates air pressure into a velocity reading on a calibrated scale. The instrument is capable of measuring velocities as low as 50 feet per minute (fpm).

Smoke tubes

Another device for testing the effectiveness of hoods is the smoke tube. The smoke tube is a glass tube which contains a granular medium on which is adsorbed titanium tetrachloride. When air is passed through the tube, the moisture in the air reacts with the titanium tetrachloride to form hydrochloric acid smoke. Obviously no attempt should be made to inhale this "smoke." Smoke tubes are most useful in visualizing flow patterns. They can be used to measure face velocities by timing the rate of flow over a known distance, but this is a very crude method of velocity estimation.

There are no other recommended techniques for rapidly determining the operating parameters of a hood system. Using other rule-of-thumb methods may result in a highly inaccurate velocity estimate which may result in further legal liability.

ESSON NO. 11

NOTES	INSTRUCTION
	LOCAL INSTRUMENT EXHAUST SYSTEMS
l exhaust systems	In the design of any new laboratory facility or in the remodeling of an old facility, it is recommended that provisions for flexibility in the exhaust system be made. The need for local exhaust ventilation occurs frequently in a laboratory operation. Many laboratory instruments and experiments generate quantities of toxic gases and vapors which should be removed at the point of generation.
trument combustion ducts	Instruments using flames often generate large quantities of combustion products and may pass varying amounts of toxic chemicals such as arsenic, mercury, and lead into the atmosphere if the equipment is being used to analyze for those particular elements.
	Local exhaust ventilation is not a necessity, but it is a device that the laboratory instructor should be aware of and should use when necessary.

LESSON NO. 11

NOTES	INSTRUCTION

RECIRCULATION OF LABORATORY ATMOSPHERES

Exhaust stack placement

Frequently in the design of laboratory facilities, poor judgement is exercised in the placement of exhaust stacks for hoods. Exhaust stacks should not be placed in the vicinity of building air intakes or upwind of any building air intakes. If these criteria are not adhered to, hazardous materials that are initially contained in a hood system and exhausted may find their way back into the general building atmosphere.

General heating and air conditioning practice is to recirculate much of the air inside a building to minimize the amount of energy needed to heat or cool 100 percent outside air. When laboratory air is recirculated, there is a very real possibility of a build-up of toxic materials occurring in the atmosphere. There is little an instructor can do in these situations other than to be aware of the possibility of recirculation problems occurring in laboratory situations. This is a problem which the instructor should pass on to the administration.

GENERAL PURPOSE SCIENCE ROOM VENTILATION

Functions of general purpose ventilation

General purpose ventilation serves two main functions. It serves to dilute the atmosphere in a given room and also to condition (heat or cool) the air in a given room. Aside from the obvious reason of heating and cooling a building, air must be introduced to compensate for the oxygen removed and carbon dioxide produced as a result of normal respiration. In most situations, sufficient air for this purpose will enter by infiltration through cracks, open doors, and windows.

Dilution ventilation

Dilution ventilation is a recognized technique for controlling atmospheric concentrations of hazardous materials. In the absence of a hood system, dilution ventilation must be used to keep atmospheric concentration below the danger level. Dilution ventilation refers to the dilution of contaminated air with uncontaminated air in a room or building for the purpose of health hazard control.

The volume of air required to dilute contaminated air can be calculated. If a particular

LESSON NO. 11

NOTES

INSTRUCTION

volatile solvent is being used in a room with no hood system, the amount of air required to dilute the room air can be calculated with the following formula:

$$\text{Cubic feet of dilution} = \frac{403\text{x}G_s\text{x}N_x\text{x}K\text{x}10^6}{\text{MWs x TLVs}}$$

where G_s = Specific gravity of the solvent

N_s = Number of pints of solvent evaporated per hour

K = Safety factor which varies between 3 and 10 and is dependent on the nature and toxicity of the solvent

MW_s = Molecular weight of the solvent

TLV = Threshold limit value of the solvent in ppm.

The use of this formula presupposes that there is knowledge of the volume of solvent evaporated in a given time and of the magnitude of the safety factor.

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5. Committee on Industrial Ventilation: Industrial Ventilation. Thirteenth Edition. Committee on Industrial Ventilation, P.O. Box 463, Lansing, Michigan 48902 (1974).

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EXHIBIT 11-1. RECOMMENDED MINIMUM AVERAGE HOOD FACE VELOCITIES IN FEET PER MINUTE (fpm)

Organization	Routine Operations	Hazardous Operations
American Chemical Society (ACS)	100	125-200
American Conference of Governmental Industrial Hygienists (ACGIH)	100	150
American National Standards Institute (ANSI)	100	150
U.S. National Institute for Occupational Safety and Health (NIOSH)	100	150
U.S. Occupational Safety and Health Administration (OSHA)	---	150 (average) 125 (minimum)

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

FIRE CONTROL

NO. 12

METHODS Lecture and Discussion **LENGTH** 30 minutes

PURPOSE

To review simple practical procedures that minimize fire hazards in laboratories, as well as basic equipment required to extinguish small fires.

OBJECTIVES

Enable the teacher to....

1) Identify potential sources of fire and explosion in the school science laboratory.

2) Compare and contrast different types of fire extinguishers.

3) Plan a self-educational project on fire prevention in the laboratory.

SPECIAL TERMS

Explosion-proof
Fire classifications
Fire resistant construction
Safety cabinet
Safety can

INSTRUCTOR MATERIALS

Lesson Plan
Slides
Chalkboard, Chalk, Eraser
Projector'(35mm) and Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 12-3

PROPER CHEMICAL STORAGE 12-4

Safety Cans 12-5

Flammable Liquid Cabinets 12-6

Explosion-Proof Refrigerators 12-8

Storage Rooms for Flammable Liquids 12-9

FIRE EXTINGUISHERS 12-10

Recharging of Extinguishers and Reserve Supply. 12-13

PROPER LABORATORY PROCEDURES 12-14

Burners 12-15

Electrical Heating. .12-15

Hazardous Reactions .12-16

Proper Clothing 12-17

Student Education 12-17

REFERENCES 12-19

LESSON NO. 12

NOTES	INSTRUCTION

INTRODUCTION

Fire has always been one of the attendant hazards of laboratory operation. Laboratories make frequent use of flammable materials including solids, liquids, gases, and vapors. The potential for extensive property damage and severe personnel injury is very high in the science laboratory. The goal of every science instructor should be to reduce the chance of fire to the lowest probability possible.

Elements of fire control program

Elements of a successful fire control program include adequate and effective education of individuals, both students and instructors, in the hazards of fire; instruction of personnel in the use of fire extinguishing equipment; the use of proper laboratory procedures; the maintenance of proper chemical storage facilities and the provision and maintenance of effective fire control equipment.

PROPER CHEMICAL STORAGE

Proper chemical storage is a critical factor in any science laboratory fire control program. There is one cardinal rule to be observed in acquiring and storing chemical compounds - chemical reagents should be purchased and stored in the smallest quantities possible. Purchasing philosophies generally require that materials, be they chemical reagents or nuts and bolts, be purchased in the most cost-effective manner. For chemical reagents, cost-effective is synonymous with large quantity and large packages. Cost should not be a factor in the acquistion of chemical reagents for the high school science laboratory. Safety and health considerations are much more important.

Purchasing philosophy

Safety and health considerations demand that only the amount of chemical reagent actually required in the foreseeable future (2 months) be stored in a science laboratory. Most chemical reagents can be delivered by supply houses in 24 to 48 hours in most areas of the country. The two month period is a recommendation and not

NOTES	INSTRUCTION
	a legal requirement.
	Safety Cans
Steere (1971) MCA (1972)	Many research laboratories use "safety cans" for storing flammable liquids. Safety cans are stainless steel or coated steel cans designed to minimize the probability of ignition of flammable vapors and avoid the accidental breakage of a flammable liquid container, usually glass, which may occur in the typical science laboratory.
	Safety cans are equipped with spring loaded closures and have flame arrestors in the spout. The flame arrestor consists of a baffle screen which smothers any flame before it can enter the can.
	Safety cans do have certain characteristics which tend to inhibit their use in some schools. They are costly, and they generally cannot be used to store high-purity flammable liquids. Purity should not be a critical factor in school science laboratories. Cost may be a factor, but the potential fire hazard presented by flammable liquids should justify the relatively small

additional cost of safety cans.

Safety cans are carefully designed to provide protection against fire. They should not be modified in any fashion for the purpose of increasing the filling or dispensing rate of the can.

Safety cans are available from a large number of domestic manufacturers.

Flammable Liquid Cabinets

Flammable liquid cabinets are often used in science laboratories to provide both protection against fire and security against improper chemical usage. Safety cabinets can be made of double-walled steel construction or of wood. They may be equipped with locks to secure the contents and with plumbing connections which permit the connection of the cabinets to a forced-air ventilation system.

The National Fire Protection Association Flammable Liquids Code, NFPA30 - 1973 allows the use of both wooden and steel cabinets.

NFPA No. 30, Sec. 42

According to the NFPA, cabinets should be designed so that the internal temperature does not exceed 325°F when subjected to a ten minute fire test using the standard time-temperature curve specified by NFPA. The code requires that the bottom, top, door, and sides of steel cabinets be double-walled with at least a 1.5 inch air space between the walls.

NFPA 30 and the OSHA regulations also contain specifications for the construction of wooden cabinets. Tests made by the Los Angeles Fire Department have shown properly constructed wooden cabinets to be at least as effective, and in many cases better, than the steel cabinets.

Steere (1971)

29 CFR 1910.106 (d) (3)

The NFPA specifies that all wood cabinets used for the storage of flammable liquids be made of an approved grade of plywood at least one inch thick with joints constructed in a certain manner. The Los Angeles Fire Department specifies that wood cabinets used for the storage of "dangerous chemicals" be constructed of wood at least two inches thick, and wood cabinets used for the storage of flammable chemicals be at least one inch thick.

The NFPA code specifies that not more than

NOTES	INSTRUCTION
	60 gallons of flammable or 120 gallons of combustible liquids may be stored in a storage cabinet.
Flammable liquid	A flammable liquid is any liquid having a flash point below 100°F and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F.
Combustible liquid	A combustible liquid is any liquid having a flash point at or above 100°F.
	Flammable liquid cabinets provide a convenient method for storing flammable and toxic chemicals when a central storage facility is not available.
	Explosion-Proof Refrigerators
	Refrigerators are common accessories in school science laboratories. Refrigerators are used to store biological materials as well as highly volatile chemical reagents. Highly volatile organic solvents must not be stored in standard domestic refrigerators. Many refrigerators have exploded when flammable vapors have been released and have been ignited by a sparking thermostat.

NOTES	INSTRUCTION
	Refrigerators for flammable liquid storage in the laboratory are available in two special designs - "explosion-proof" and "explosion-safe". In explosion-proof refrigerators, the electrical components are enclosed in explosion-proof housings both inside and out. Hence they may be used to store flammables and also can be used where flammable vapors can be present on the outside of the unit. Explosion-safe models have no ignition sources on the inside but are not suitable for use in areas where flammable vapors can be present on the outside. The latter is less expensive and is usually adequate for a school laboratory. Standard domestic refrigerators cannot be satisfactorily modified to be safe for flammable liquid storage.
	Storage Rooms for Flammable Liquids School science laboratories sometimes have specially built rooms or special buildings for the stroage of flammable chemicals. A special isolated storage room is recommended for laboratory facilities that stock over 50 gallons of

flammable liquid. This is strictly a recommendation and not a legal requirement.

There are no Occupational Safety and Health (OSHA) standards which specify when an inside storage room is to be used.

Powered mechanical exhaust systems must be provided for storage rooms in which liquids with flash points below 100° are stored. The exhaust rate should be one cubic foot per minute of exhaust per square foot of floor area, but not less than 150 cubic feet per minute. The intake must be located within 12 inches from the floor.

OSHA regulations require that inside storage rooms have at least one clear aisle with a minimum width of three feet.

The exit(s) for the inside storage room must be clearly marked and not blocked in any way. OSHA regulations or NFPA30 should be consulted for other important design factors.

FIRE EXTINGUISHERS

Fire extinguishers are commonly found in school buildings because they are required by law. This does not mean that the right fire extinguishers are found in the proper places, however, or that the teachers and students know how to use them. Successful fire control in the school laboratory is often a matter of having the proper fire extinguisher and someone who knows how to use it.

Classes of fires

There are four recognized classes of fires: Class A, Class B, Class C, and Class D. Class A fires are those which occur in ordinary combustible materials including wood, paper, cloth, and plastics. Class B fires are those which are fueled by flammable liquids - gasoline, mineral spirits, alcohol, etc. Class C fires are fires originating in electrical equipment. Class D fires are those fueled by combustible metals such as sodium potassium and magnesium.

Fire extinguishers are labeled with an A, B, C, or D or any combination of the designations to indicate which classes of fires they can be used to extinguish. The labels on extinguishers also contain directions for their use. The instructor and students should be familiar with the operating instructions for all fire extin-

NOTES	INSTRUCTION
	guishers in the laboratory. Class A fires can be extinguished with water, dry chemical, or halogenated hydrocarbon (halon) portable extinguishers. The ABC dry chemical unit is extremely effective and is preferred. Water may also be quite adequate and avoids the undesirable deposit of powder on all nearby surfaces. Class B fires can be extinguished by carbon dioxide, dry chemical or halon extinguishers. Carbon dioxide extinguishers are excellent for small flammable liquid fires when properly used. In unskilled hands the carbon dioxide discharge may result in the burning liquid being spread. For larger Class B fires, either BC or ABC dry chemical extinguishers are highly effective. Class C fires, in electrical equipment, can be extinguished by carbon dioxide, halon, or dry chemical extinguishers AFTER THE CURRENT HAS BEEN SHUT OFF. Water should be avoided because it is a conductor. Class D fires require special extinguishing agents applied from an extinguisher or shoveled

NOTES	INSTRUCTION
	from a bucket. Sodium and other such metals may react with carbon dioxide or halons. Proper location of extinguishers is critical. They must be near enough to procure and use without delay - generally 50 feet or less. They should all be located at room exits, not deep in the room. When a person goes for an extinguisher he should be going toward safe egress. Recharging of Extinguishers and Reserve Supply All pressurized fire extinguishers must be monitored to ensure that the pressure is sufficient to provide the necessary propulsive force for the contents of the extinguisher. Nearly all commercial extinguishers have pressure gauges which indicate the current status of the extinguisher charge. Most extinguisher users contract out the inspection and recharging of extinguishers. Inspections of extinguishers are made on a regular basis by the contractor, and those that require recharging are recharged. Recharging can be done on-site or at a remote location. If the extinguishers are re-

moved from the school or laboratory area, a reserve supply of extinguishers may be necessary to maintain protection at the required level.

OSHA regulations require that extinguishers be checked monthly to see that they are in place, their seals are unbroken and they are accessible.

PROPER LABORATORY PROCEDURES

Fire can easily occur in any laboratory. An understanding of the nature of fire is essential if a proper and adequate fire control program is to be established. In order for a fire to occur all of the necessary components that make up the fire reaction must be present. There are three components necessary for the vapor-phase reaction called fire. These are: (1) a supply of fuel; (2) a source of heat or ignition; and (3) a source of oxygen. If any of the three components is absent, a fire cannot start or continue.

Fire reaction components

Strict attention to the controllable components in the laboratory will go a long way toward minimizing the chance of fire. The control of some fuels - flammable liquids - has already been discussed. The presence of oxygen is, of course, one factor that generally cannot be controlled. All school science instructors should take great pains with controlling heat and ignition sources in the laboratory.

Burners

Gas burners commonly used in laboratories are indispensible for many purposes. Occasionally they are used improperly. Flame burners must be treated as carefully as any other source of open flame and should be extinguished immediately if flammables are spilled or released. They should never be used as a source of heat for evaporating flammable liquids.

Hot water baths and steam baths can often be used instead of burners when flammables are involved.

Electrical Heating

Where possible electric mantles and hotplates should be used whenever a source of heat is required in the laboratory. Electric heaters do not present the danger to personnel that an

NOTES	INSTRUCTION
	open flame does. They will not, under ordinary circumstances, ignite hair or clothes.

Hazardous Reactions

Hazardous reactions are those operations which involve the combination of two or more chemical compounds or elements with a resultant fire, explosion, or evolution of toxic or noxious material. The number of potentially hazardous chemical reactions is considerable. One manual lists approximately 3500 different chemical reactions as being potentially hazardous. (NFPA No. 491M, 1975).

Unstable materials are sometimes present in laboratories but are rarely needed in school laboratories. They can decompose, polymerize, condense, or otherwise release energy when such self reactivity is initiated by heat, catalyst, or other means.

Studying and listing all of the likely hazardous reactions is beyond the scope of this manual. Information on hazardous reactions can be found from the references listed at the end of this lesson.

NOTES	INSTRUCTION
	Proper Clothing

Proper Clothing

Both students and instructors should wear appropriate clothing in the science laboratory. When selecting clothing for laboratory wear, prime consideration is given to protecting the wearer against chemical contact. However, the ability of the clothing to protect the wearer against fire must also be considered. Fire is an ever present danger. Certain clothing materials are much greater fire hazards than others. The polyester fabrics will burn much more readily than cotton fabric will.

Students should be encouraged to wear cotton clothing whenever possible in the laboratory. Cotton lab coats provide some protection against fire. Many of the new, disposable lab coat fabrics burn quite readily despite the claims of the manufacturer. Any laboratory using these coats should thoroughly investigate their fire-resistant properties before using them.

Student Education

Student education in fire control and fire protection in the laboratory is essential in the

LESSON NO. 12

NOTES	INSTRUCTION
	operation of any school science program. Students must be educated in all aspects of fire control as well as the normal fire dangers inherent in laboratory operations. Teachers should have hands-on training in the proper use of various fire extinguishers. The local fire department would be happy to arrange a series of demonstration fires and give practive in extinguishment.

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SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

LABORATORY HARDWARE

NO. 13

METHODS Lecture and Slides **LENGTH** 30 Minutes

PURPOSE

To provide a summary of safety and health hardware available for laboratories

OBJECTIVES

Enable the instructor to --

1) Know what is commercially available in the safety products line
2) Understand the deficiencies in his or her own hardware selection
3) Specify specific items of hardware to improve a laboratory safety and health program

SPECIAL TERMS

Safety shower
Eyewash fountain
Spill control package
Grounding

INSTRUCTOR MATERIALS

Lesson text

35 mm slides

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 13-3

SAFETY SHOWERS 13-4

EYEWASH FOUNTAINS AND STATIONS 13-8

SPILL CONTROL PACKAGES 13-11

ELECTRICAL SYSTEMS 13-12

- Grounding 13-12
- Testing 13-13
- High Voltage in Instruments 13-13
- Precautions to be Followed in Dealing with Electrical Systems and Equipment 13-14

LIGHTING SYSTEMS 13-16

- Hazards of Poor Lighting 13-16
- Lighting Requirements 13-17
- Testing of Lighting Systems 13-17

SIGNS AND SYMBOLS 13-18

RADIATION PROTECTION 13-19

LESSON NO.

NOTES	INSTRUCTION
	INTRODUCTION
	This lesson covers laboratory hardware which includes both the accessory equipment available for use in the laboratory which is essential for the safety of the individuals working in the laboratory, and the equipment which comprises the laboratory itself, such as the electrical system, the lighting system, and the ventilation system.
Accessory equipment	Accessory equipment includes safety showers, eyewash fountains, spill control packages, fire extinguishers and miscellaneous safety equipment which might be found in any science laboratory. Some of this equipment has been covered in other sections of this manual.

LESSON NO. 13

NOTES	INSTRUCTION

SAFETY SHOWERS

Safety showers are essential components of any adequate science laboratory safety program. If, in any laboratory, the danger of caustic or acid burns, contact with toxic chemical reagents, or clothing fires exists, safety showers should be installed for the personnel of that laboratory.

Deluge safety showers

Safety shower heads must be a non-clogging deluge type to permit delivery of the large flow of water needed to instantly cover a contaminated area of skin with a virtual flood of water.

Safety shower valves are of two types, (1) a self-closing valve which remains open for about a minute each time it is opened, and (2) a full flow ball valve that remains open until it is closed. Actuating devices available include pull chain, pull rod and ring, and push panels.

A good water supply is essential for a safety shower. The service line should be 1 inch pipe and supply pressure at the valve should be no less than 20 pounds per square inch.

Each shower should have a shut-off valve protected from tempering or unauthorized persons. Shut-off valves should never be left closed except while work is being done on the shower.

Shower tests

Showers should be tested at least every six months but preferably more often to ensure that they are functioning properly. Plumbing fixtures corrode and some shower heads plug up. In areas where the water hardness is high, the showers should be checked every month. Regular tests will reveal any problems which can then be corrected.

Safety showers are available from a number of commercial firms. They are available in a variety of materials, the most common being brass, plastic, and stainless steel.

Shower location

Safety showers are commonly installed in corridors so that they can serve more than one laboratory. The number of showers to be installed and their locations must be given careful consideration. Large laboratory rooms may require the installation of one or more showers

LESSON NO. 13

NOTES	INSTRUCTION
	inside the room rather than in the corridor. Of course safety showers should be immediately available in laboratory areas in which the chance for harm is much greater than in other areas. Areas in which substantial quantities of caustic materials or acids are used should have immediate access to a safety shower. There are no uniform, generally accepted requirements governing the installation, use and maintenance of safety showers. The following specifications governing shower installation have been reported in the literature as acceptable for most laboratory situations.
Sterns (1971)	1. Showers should be located no more than 25 feet from the laboratory entrance. This specification obviously has to be modified by good judgement as mentioned above.
	2. Showers should not be located in the vicinity of electrical apparatus or power outlets or panels.
	3. The shower locations should be indicated by painted circles or squares on the floor. This area should be kept clear.

4. Showers should be located near floor drains if possible.

5. Showerheads should be located 7 to 8 feet above the floor and a minimum of 25 inches from the nearest wall.

6. The shower valve should be operated by a ring and chain, triangle and rod, or chain arrangement. The ring and triangle must be large enough to allow the entire hand to fit inside and grasp the ring or triangle comfortably.

7. The shower flow rate should be between 30 and 60 gallons per minute under a pressure of 20 to 50 pounds per square inch.

8. The water service line should be 1 inch diameter minimum.

9. No individual in the laboratory should have to travel further than 50 feet to reach a shower.

EYEWASH FOUNTAINS AND STATIONS

Eyewash fountains are devices designed to provide a relatively gentle flow of aerated water to cleanse the eye of foreign substances.

Eyewash fountains come in a number of configurations. They can be free-standing units or they can be part of an eyewash fountain safety shower combination.

Eyewash fountains are actuated by push bars, push plates, or foot treadles. They are equipped with stay-open ball valves so that the fountain user can use his hands to keep his or her eyes open while they are being irrigated.

The recommended water supply pressure for eyewash fountains is 25 pounds per square inch (psi), and the recommended water supply temperature is 110°F or less. Water warmer than 110°F is too hot for comfort. Cold water, even ice water, is usuable for irrigation purposes.

Also commercially available are hoses equipped with spray heads and hand-operated squeeze valves. These units are useful in addition to or in place of an eyewash fountain.

LESSON NO. 13

NOTES	INSTRUCTION
	They are best located under a safety shower and should be both visible and accessible in an emergency.
Portable fountains	Portable eyewash fountains are available which consist of the hose and spray head discussed above and a pressurized water tank. These units approximate a typical fire-extinguisher in size and weight. They should be used if hazardous work must be performed in the field or any area in which eyewash fountains are not available.
Eyewash stations, bottles	Other devices sometimes provided for cleansing eyes and which are used occasionally are eyewash stations, eyewash bottles, and chemical burn stations. Most are very inadequate.
	Eyewash stations consist of a wall bracket which holds a plastic bottle of dilute boric acid solution or water. The bottle is usually equipped with a cup which fits over the eye.
	Eyewash bottles are plastic bottles equipped with special cups which fit over the eye. They can stand alone or be fitted into wall brackets.

LESSON NO. 13

NOTES	INSTRUCTION
	Chemical burn stations consist of a wall bracket with a plastic bottle containing a ventral, phosphate butter solution. The bottle contents are poured into the eye. The devices just discussed - eyewash station, eyewash bottle, and chemical burn station - all have the disadvantages of being limited in cleansing capacity and difficult to find at the critical moment. They should never be considered as an alternate to eyewash fountains. Eye specialists favor water only and lots of it for 15 minutes minimum as the proper first aid treatment for chemical splash in the eye.

LESSON NO. 13

NOTES	INSTRUCTION
	SPILL CONTROL PACKAGES

SPILL CONTROL PACKAGES

Some chemical manufacturers are producing spill control kits designed to minimize the harmful effects of a chemical spill by absorbing the chemical and restricting its movement across the laboratory floor. The kits usually consist of a pail containing a mixture of sand and soda ash. Floor drying compounds such as are used by garages are also cheap and effective for spill absorption. These kits can be easily made up by students and can be an interesting student project.

NOTES	INSTRUCTION
	ELECTRICAL SYSTEMS Electrical systems are generally outside of the scope of the average high school science teacher's area of responsibility. The electrical system is commonly the responsibility of the building architect and design engineer. Electrical system maintenance is generally the responsibility of the school building maintenance people. However, each science teacher should learn the location of switches that would cut off power to his laboratory. Grounding
Grounded outlets	The grounding of laboratory electrical systems and electronic instrumentation is essential for the safe operation of the laboratory. All new laboratory installations are or should be equipped with grounded electrical outlets. Older laboratories that are still equipped with ungrounded outlets should be modified as quickly as possible to provide an adequate and safe ground for electrical equipment. The upgrading of laboratory electrical systems

NOTES	INSTRUCTION
	deserves the highest priority and should be supported to the utmost by all instructors. Before an instructor attempts to alter, modify or otherwise work with the grounding system, he should seek the advice of qualified individuals. This is a task better left to the school maintenance personnel. **Testing** Electrical systems and instrumentation can be checked for adequacy of ground. This should be done by a qualified individual, unless an instructor is well versed in the testing of electrical systems. **High Voltage in Instruments** Nearly all electronic instrumentation used in the laboratory contains a high voltage section in the instrument. Properly designed instrumentation should have interlock switches that serve to cut off electricity to the unit if the cabinet is opened while the instrument is still on. The voltages in the high voltage

LESSON NO. 13

NOTES	INSTRUCTION
	sections of many instruments are capable of causing serious harm to any individual unfortunate enough to encounter them.
	Precautions to be Followed in Dealing with Electrical Systems and Equipment
	1. Use extension cords only when absolutely necessary and keep power cords as short as possible. Put them away after each use.
Ehrenkranz (1971)	2. Whenever current leakage is detected in a piece of equipment (shock or tingling feeling), pull the piece of equipment out of service immediately and send it out for repair. Insulation faults do not correct themselves; they get worse with time.
	3. Make sure that the addition of electrical equipment to existing electrical systems does not overload that system.
	4. Do not handle electrical equipment with wet hands or perspiring hands or while standing on a wet floor.
	5. When checking electrical equipment for overheating, check only with the back of one hand. If an electric shock is received, an

LESSON NO. 13

NOTES	INSTRUCTION
	involuntary muscular contraction will not cause the individual to grab the piece of equipment.

LESSON	NO. 13
NOTES	**INSTRUCTION**
	LIGHTING SYSTEMS One element of laboratory hardware which is frequently overlooked is the lighting system. Illumination levels are critical because of the large variety of hazards which exist for the unwary in the average science laboratory.
	Hazards of Poor Lighting The hazards of poor lighting are self-evident. At low levels of illumination, obvious
Allen (1976)	dangers are not as readily seen. Eye discomfort and fatigue increase as a result of poor lighting. The increased stress placed on individuals by poor lighting does not directly damage the eye but may result in headache and nausea. An individual who is suffering from the effects of poor lighting - headache, fatigue, nausea - is less likely to be as alert as he or she should be when working in the laboratory. This lack of alertness can easily result in laboratory accidents.

LESSON NO. 13

NOTES	INSTRUCTION
	Lighting Requirements
Brief (1975)	The recommended illumination level for general laboratory work areas is 50 foot-candles or more. Illumination level is defined as the amount or quantity of light falling on a surface and is measured in foot-candles. A foot-candle is equal to the illumination which results when a uniformly distributed flux of one lumen falls on a one square foot surface area. A lumen is the unit of light output from a light source.
	Testing of Lighting Systems
	Illumination levels can be easily and quickly measured by pocket-size illumination meters. There are more sophisticated instruments available, but their features are not necessary for evaluating laboratory illumination levels.

LESSON	NO. 13
NOTES	INSTRUCTION

SIGNS AND SYMBOLS

High school laboratories should make liberal use of available signs and symbols in order to promote a safer environment. There are few mandated signs or symbols. Display of the radiation symbol is required by federal and state law wherever radioactive materials are being used.

Biohazard signs may also be required by state or federal law. Fire extinguisher signs are required by state and local law. All effective laboratory operations utilize signs and symbols as an important element of the safety program.

Stock wording is available from many venders in signs made of enameled sheet metal or laminated fibre-glass. Self adhering cloth or plastic signs are also available with standard wording.

LESSON	NO. 13
NOTES	INSTRUCTION

RADIATION PROTECTION

High school laboratories have been known to make use of radioactive materials. If radioactive materials are used, there must be suitable storage and protective equipment available. Because of the hazard presented by radioactive material, it should be stored in a locked cabinet or compartment. If the activity of the radioactive substance is high enough, a special lead lined, key-operated box may be necessary for adequate protection.

For routine laboratory work with radioactive materials, the laboratory should maintain a supply of shielding materials including lead sheet, lead bricks, and cement blocks. Personal protective equipment - lead filled gloves and aprons - may also be necessary if maximum protection is desired.

Some type of radiation monitoring instrument is also essential and a trained radiation safety officer is required to maintain safe conditions.

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

RECORDKEEPING — NO. 14

METHODS Lecture and Discussion

LENGTH 20 Minutes

PURPOSE

To provide the instructor with a background in recordkeeping practice in science laboratories including the applicable legal requirements.

OBJECTIVES

Enable the trainee to...

1) Understand the legal requirements for recordkeeping.
2) Identify the types of records to be kept.
3) Establish a suitable record system in his or her own science laboratory.

SPECIAL TERMS

Accreditation
Carcinogen
Respirator

INSTRUCTOR MATERIALS

Lesson Text
Slides
Projector (35 mm) & Screen

TRAINEE MATERIALS

Note-taking

CONTENTS

INTRODUCTION 14-3

INVENTORY RECORDS. 14-6

    Chemical Reagent Inventory Records. 14-6

    Instrumentation Inventory Records 14-10

    Personal Protective Equipment Inventory Records 14-11

    Fire Extinguisher Records 14-12

REPAIR AND INSPECTION RECORDS. 14-13

INJURY RECORDS 14-15

INCIDENT RECORDS 14-17

STUDENT ASSIGNMENTS AND AGREEMENTS 14-18

EXHIBIT 14-1 14-21

EXHIBIT 14-2 14-23

LESSON	NO. 14
NOTES	**INSTRUCTION**
	INTRODUCTION
	Recordkeeping has always been an integral part of laboratory operations and also a normal part of the instructor's duties. Instructors are required to keep attendance and grade records. Laboratories keep records as an incident to good practice, and occasionally, as a result of a legal requirement to do so.
Recordkeeping misconceptions	It is a common misconception that laboratories must keep records of analyses and daily activities. This is not true! Other than for legally regulated laboratories, e.g. clinical and hospital laboratories, there is no legal requirement to maintain daily work records. Some voluntary standards organizations such as the American Society for Testing and Materials (ASTM) and the American Industrial Hygiene Association (AIHA) have established voluntary accreditation programs which require that accredited laboratories maintain a detailed recordkeeping system. But there are no statutes, state or federal, which require that daily work records be kept.

NOTES	INSTRUCTION
	Even though school science laboratories probably do not keep records which relate directly to the laboratory operation as opposed to those which relate directly to students' performance, they should be encouraged to do so. Maintaining adequate records is a key element of any successful safety program. Good records will allow laboratory personnel, both teachers and students to spot trouble before it occurs, or determine causes if an accident happens.
Legal benefits	Laboratory records are useful as an aid in delivering testimony while serving as a witness in a legal proceeding. If records are routinely and accurately kept, they may be admitted as evidence in a court of law even though the maker of the records is unavailable or cannot recall the events from which the record was drawn.
	These two benefits are the primary reasons for establishing the recordkeeping psychology in students. As a matter of good practice, commercial laboratories require their employees

LESSON NO. 14

NOTES	INSTRUCTION
	to keep daily work records. Students should be taught as early as possible the benefits and desirability of adequate recordkeeping.
Minimizing legal liability	Records such as chemical reagent inventory records, repair and inspection records, injury records, and incident records are extremely valuable in setting up an ongoing, viable safety and health program. They can also be useful to the instructor as a means of minimizing his or her legal liability in the case of bodily injury or property damage.
	In some cases the school may have no choice in deciding whether or not it wants to keep records. Schools which are subject to the provisions of the Occupational Safety and Health Act of 1970 (OSH Act) must keep injury and incident records. These schools include all private and parochial schools and all public schools in states which enforce the OSH Act under an acceptable state plan.

INVENTORY RECORDS

There is no excuse for a school science laboratory not having readily available inventory records covering the chemical reagents in stock, the existing instrumentation, and miscellaneous items such as glassware, fire extinguishers, and personal protective devices.

All of these records play an important part in the operation of a laboratory safety and health program. If the students are involved in the recordkeeping system, they can develop and acquire work habits that will stand them in good stead through their college and professional years.

Chemical Reagent Inventory Records

An up-to-date inventory of the chemical reagents in stock is essential to the safe and efficient operation of a science laboratory. The constant turnover of students and the frequent turnover of instructors contributes to the need for establishing an inventory system capable of providing immediate information on every chemical reagent stored in a school building.

Chemical inventory records are an integral part of any formal health and safety program.

Adequate written records allow inventory searches to be made rapidly. As the health and safety hazards presented by certain chemicals become recognized, it may become necessary to remove the chemical compounds from school shelves. A case in point is the list of proscribed carcinogens developed by OSHA. Many school science laboratories contained one or more of these compounds, and the instructors were, and in many cases still are, unaware of the potential hazard. As more compounds are placed on the proscribed list, more compounds will have to be removed from the shelves of high school science laboratories.

Proscribed carcinogens

A uniform, orderly system of recording purchase dates, receiving dates, quantities received, quantities used, and disposal date is necessary if the school and the instructor are to keep up with the ever-increasing flow of information on hazardous chemicals. As a

Christensen (1975)

LESSON NO. 14

NOTES

INSTRUCTION

companion to the OSHA list of proscribed carcinogens, the National Institute for Occupational Safety and Health (NIOSH) publishes a list of suspected carcinogens. These are chemical compounds or elements that are suspected of causing cancer in laboratory animals. The use of these compounds should be restricted where possible. Wherever these suspect chemicals are in use, they should be substituted for if possible. If necessary, experiments should be changed to circumvent the use of potentially carcinogenic chemicals.

Dating system

Time-sensitive chemicals

All chemical reagents, upon receipt in the laboratory, should be immediately marked with the receiving date. The reason for dating the reagent is the time sensitivity of certain chemical reagents. Many chemical reagents are oxidized by atmospheric oxygen over a period of time. The effect of this can be minimal, i.e., the reagent will not perform properly in a chemical test and a new batch of reagent will have to be acquired or prepared. An example of the minimal effect of time sensitivity is the oxidation of o-tolidine. Once oxidized, this material will not perform properly in colormetric procedures utilizing it as one of the color forming agents.

On the otherhand, some materials are time sensitive in a dangerous fashion. Ethel ether and dioxane, for example, form explosive peroxides after sitting for varying periods of time. These chemical compounds should be disposed of before peroxides can form. An inventory control system would allow the routine removal and disposal of time sensitive chemical compounds.

The amount of time an instructor can devote to maintaining chemical usage and inventory records is limited. If the instructor wants to maintain a complete records system, he or she may have to devote considerable time to it.

Chemical reagent record information

There should be a record for each chemical reagent which lists the date received, quantities withdrawn, when withdrawn and by whom, the date disposed of and the disposal method. Ideally students will get involved in the recordkeeping system and remove much of the burden from the instructor's shoulders.

Inventory records could be disigned to contain more information. They could list special precautions to take in handling the chemical, toxicity data, and safety data. Compiling these types of information might be prohibitive for the average science instructor, but it would serve as a useful project for one or more students.

Instrument Inventory Records

Instrument inventory records should record the dates of purchase, routine maintenance checks, and all repairs. These records will serve as a quality control check on the instruments and they may aid the instructor in defending a liability suit. Maintaining instruments in safe operating condition is a normal function of a science teacher. Written records are acceptable, legal proof that this responsibility has been effectively carried out by the teacher.

LESSON **NO.** 14

NOTES	INSTRUCTION
Preventative maintenance	Personal Protective Equipment Inventory Records Science teachers often keep some type of written record of personal protective equipment that is issued to students. These records are kept to control equipment losses rather than provide maintenance information. Inventory records on personal protective equipment should be maintained, however, because many types of personal protective equipment require preventative maintenance. Protective eyewear require regular cleaning and disinfection. If proper maintenance procedures are not performed on the personal protective equipment which requires them, the equipment may actually magnigy a health hazard or serve as the source of a new hazard. Respirators with expired cartridges can create a false sense of security in the wearer. The wearer can be exposed to chemical hazards while thinking he or she is protected. Dirty respirators and safety glasses can serve as the source of infectious microorganisms or as the source of skin-penetrating, toxic chemicals.

NOTES	INSTRUCTION
	Records that are kept up to date will enable the instructors and the students to make informed decisions regarding the condition and suitability of equipment for use. The compilation of this type of written record is an integral part of a safety and health program. Students may be effectively integrated into this portion of the program. With supervision they can be given the responsibility for keeping the written inventory record and for performing the required maintenance procedures on the equipment. There is no recommended format for keeping records of this type. A suitable record form should be easy to construct. It can be made a student safety project. Fire Extinguisher Records Fire extinguishers must be readily available in high school science laboratories. When needed, they must work. In order to insure that an extinguisher will function when needed, a program of regular checking, maintenance, and repair must be established and operated.

NOTES

INSTRUCTION

Fire extinguisher records should list extinguishers by type, location, recharge periods, and size. Records of available spare parts and spare extinguishers must also be maintained. Generally fire extinguisher maintenance will be performed by an outside service company. Their visits should be scheduled in advance and noted on the written record.

REPAIR AND INSPECTION RECORDS

Repair and inspection records are another facet of laboratory operations. Written records contribute valuable information about the day to day problems of running a laboratory, but most importantly, adequate records are indicative of an instructor who is attuned to the social, legal, and economic currents of the times.

The general public is more aware of health and safety problems now than at any time previously in the history of the country. The public demands that schools provide a safe and healthful learning environment for young people. This is a social policy.

LESSON NO. 14

NOTES	INSTRUCTION

Repair and inspection records are economic essentials. They serve to pinpoint equipment that may be subject to an undesirable number of breakdowns. Equipment that breaks down often requires more frequent repairs and excessive spending. Equipment that is subject to frequent breakdown may present a greater safety and/or health hazard than more durable equipment. Equipment that is placed on a regular maintenance schedule supported by written records is much less likely to become a laboratory health or safety hazard.

Inspection and repair records also can serve as valuable elements of a legal defense. If a student is injured while using a particular piece of equipment, it is possible that a teacher could be charged with negligence in maintaining the item of equipment. Records that show a regular practice of inspecting and repairing equipment can be used to refute a claim of negligence.

Inspection records which cover routine, periodic inspections are another element of a successful safety program. For schools and

NOTES	INSTRUCTION
	school districts which are amendable to OSHA regulations, inspections may be required in order to insure that the school facilities and operations are in compliance with the applicable regulations. Laboratory facilities may have to comply with the regulations governing the storage of flammable liquids, adequate electrical wiring, signs and labels, and exposure to hazardous chemical and physical agents. Inspection records also provide information on potential problem areas and allow the teacher to take remedial action before any problem occurs. Routine inspections may be carried out by students as a way of increasing their participation in the safety program aspect of the laboratory operation. INJURY RECORDS At the present time there is no known central depository for school injury records relating to the science laboratory. This is unfortunate because it deprives science teachers of a valuable tool in fighting the

LESSON NO. 14

NOTES	INSTRUCTION
	problem of science laboratory accidents. If the major accident problem areas were known with some degree of certitude, teachers could take specific steps to remove or control these known hazards in their own laboratories.
Existing recordkeeping systems	There are two accident and injury recordkeeping systems in common use in this country. These are the American National Standards Institute (ANSI) Z16.1 system and the OSHA system. The Occupational Safety and Health Administration has promulgated regulations which govern the recording and reporting of occupationally induced illnesses and injuries.
	The ANSI system is also designed for use primarily for industrial accidents. It is a more detailed system than the OSHA system and is probably beyond the scope of most school operations. However, the concepts represented by these two systems are important and should be extended to student injuries where possible.
	Accident and injury records can be of inestimable value to the teacher in any

NOTES	INSTRUCTION
	future litigation regarding the student injury. If the school has adopted a uniform system of accident reporting, the accident records should be readily admitted as evidence in any court of law.
	A recommended accident form, based on National Safety Council form IS-IA-25M-37301 is presented in Exhibit 14-1. This recommended form provides for the collection of all relevant data concerning an injury producing accident.
	The recordkeeping requirements of OSHA and the specified forms are presented in Appendix 14-A. The material in the Appendix is self-explanatory. The OSHA recordkeeping requirements do not extend to students unless the students involved are serving as employees of the school.
	INCIDENT RECORDS
Incidents	Incidents may be defined as those events and occurrences in science laboratories which are undesirable and may, but not necessarily do, result in personnel injury. Such events

NOTES	INSTRUCTION
	as spills of caustics or acids, small fires, breaking of glass, and electrical shock would qualify as incidents. Keeping records of these incidents will serve to alert the laboratory teacher of possible danger areas incidental to a particular laboratory or a particular group of students. Incident records may not prove to be conclusive in a single school setting. Data should be collected over district and state territories in order to provide statistically valid information concerning the frequency of occurrences of specific incidents. At the present time there is no known program of this type being conducted. STUDENT ASSIGNMENTS AND AGREEMENTS Much of the material covered in the modules on laboratory has had the dual purpose of assisting the science teacher in providing a safe place for his/her students to work and learn and of aiding the teacher in minimizing his/her legal liability at the same time.

LESSON NO. 14

NOTES	INSTRUCTION
	The two purposes are not mutually exclusive. If the teacher accomplishes the first goal, he/she must necessarily accomplish the other. In the prior lesson modules, the teacher's duties of supervision and instruction were discussed. One aspect of these two duties is providing adequate instruction and information to the students on particular assignments or experiments.

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EXHIBIT 14-2. RECORDKEEPING REQUIREMENTS UNDER THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

Recordkeeping Requirements

Under the Occupational Safety and Health Act of 1970

This booklet contains new recordkeeping forms which must be used to record work related injuries and illnesses which occur on or after January 1, 1975. It also contains current information about recordkeeping responsibilities under the Occupational Safety and Health Act of 1970. It replaces a booklet which was issued in 1971.

U.S. DEPARTMENT OF LABOR

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

REVISED 1975

RECORDKEEPING REQUIREMENTS

The Occupational Safety and Health Act requires that records of occupational injuries and illnesses be prepared and maintained. The Bureau of Labor Statistics is responsible for developing and maintaining an effective recordkeeping program. In most States, a statistical grant agency cooperates with the Bureau in administering the recordkeeping program. Records of injuries and illnesses are necessary for carrying out the purposes of the Act. They are designed to assist compliance safety and health officers in making inspections and investigations. They also provide the basis for a statistical program which produces reliable injury and illness incidence rates and other measures. This information, together with required supplementary records, will be helpful in identifying many of the factors which cause injuries and illnesses in the workplace.

The following presentation summarizes the OSHA recordkeeping regulations, and should answer most of your questions about OSHA recordkeeping. Further information can be obtained from the statistical grant agency or, if there is none, from the Bureau of Labor Statistics Regional Office. See pages 6 and 7 for addresses.

Most, But Not All, Employers Must Keep Records

1. Most private employers are required to keep OSHA records; however, recordkeeping is not required for the following employers:

   Small employers which employed no more than seven (7) full- or part-time employees at any one time during the previous calendar year. A few small employers will have to maintain records if they are selected to participate in the annual survey of occupational injuries and illnesses. They will be notified in advance and supplied with the necessary forms and instructions. Also, State safety and health laws may require small employers to keep injury and illness records.

   NOTE: If an employer has more than 1 unit and a total of more than 7 employees, records must be kept for all individual units.

   Mining employers are not required to keep records or report under the Occupational Safety and Health Act, since the Department of the Interior has adopted a program of recordkeeping and reporting, developed in cooperation with the Bureau of Labor Statistics, which produces similar information.

   Employers of domestics in the employer's private residence for the usual purposes of housekeeping or child care, or both.

   Farm employers whose only workers are members of the farm-employer's immediate family or whose workers are neighbors who help them at specified times as a neighborly gesture.

   Employers in religious activities but only with respect to the conduct of religious services or rites. Employees engaged in such services or rites include clergymen, choir members, organists and other musicians, ushers, and the like. NOTE: Records of injuries or illnesses occurring to employees while performing secular activities must be kept. Recordkeeping is also required for employees of private hospitals, schools, orphanages, and commercial establishments owned or operated by religious organizations.

2. Agencies of State and local governments are required to keep records as to their employees only as their own State occupational safety and health plans gain Federal approval.

Location of Records

Ordinarily, records must be maintained at each establishment (workplace). See the reverse side of form OSHA No. 100 for a definition of the term establishment. If an employer has more than one establishment, a different set of records must be maintained at each one.

Some firms, such as those engaged in agriculture, construction, transportation, and the like, have activities which are physically dispersed. Records of injuries and illnesses to employees engaged in such activities can be maintained at the place where employees report each day. If such employees do not regularly report to the same place, records may be maintained at a central place for each group of employees regularly supervised by the same person. If records are maintained centrally, two conditions must be met. One, the address and telephone number of the place where the records are kept must be available at the worksite; and two, there must be personnel available at the central place during normal business hours to provide information from the records.

Some employees, such as traveling salesmen and technicians, do not report to a single establishment and are not generally supervised in their daily work. Records for such employees shall be maintained either at the base from which they operate or at the place from which they are paid.

Preparation and Maintenance of Records

OSHA recordkeeping is not complicated. Only three forms must be maintained. A copy of each is found in this booklet.

The Log (OSHA No. 100)

The log is a convenient means for classifying injury and illness cases and for noting the extent of and outcome of each. Not every injury or illness occurring in the workplace is recordable. Definitions on the back of the OSHA No. 100 will explain how to determine which cases must be recorded. The employer must enter each recordable case on the log within six (6) workdays after learning of its occurrence. The OSHA No. 100 contains complete instructions for doing this.

A substitute for the OSHA No. 100 is acceptable if it is as detailed, easily readable and understandable as the OSHA No. 100. For example, if data processing equipment is used to log injuries and illnesses, the format of the printout must be similar to that of the OSHA No. 100.

Although other records must be maintained at the establishment to which they refer, it is possible to prepare and maintain the log at another location, using data processing equipment if desired. If the log is prepared elsewhere, a copy updated to within 45 calendar days must be present at all times in the establishment.

Logs must be kept current for five (5) years following the end of the year to which they refer. If there is a change in the extent of or outcome of a case previously entered on the log, the first entry should be corrected. See the section titled "Changes in Extent of or Outcome of Injury or Illness" on the reverse side of OSHA No. 100. If a case is later determined to be nonrecordable, it should be lined out.

The Supplementary Record (OSHA No. 101)

For every recordable injury or illness, it is necessary to record additional information requested on the OSHA No. 101 form. The

OSHA No. 101 form does not have to be used. Workmen's compensation insurance or other reports are acceptable supplementary records if they contain all items found on the OSHA No. 101 form. If they do not, the missing items must be added somewhere on the same form or on a separate attachment.

Supplementary records must be completed and present in the establishment within six (6) workdays after the employer has been notified of an injury or illness case.

The Summary (OSHA No. 102)

At the end of each calendar year, a summary of log entries for each establishment must be prepared on an OSHA No. 102 form. Substitutions for this form are not acceptable. A copy of this summary must be posted no later than February 1 and remain in place until March 1, in a place where all employees are likely to see it. An employer who has on his February payroll employees not reporting to a fixed establishment on a regular basis must present or mail a copy of the summary to each of them. It is not necessary to post the summary in establishments which are closed during February.

Retention of Records

All records must *remain in the establishment* for five (5) years after the year to which they relate. If an establishment changes ownership, the new employer must preserve the records for the remainder of the five-year period. He is not responsible, however, for updating records of the former owner.

Poster

Each employer must display in each establishment a poster which explains the protections and obligations of employees under the Occupational Safety and Health Act. States which have approved plans will require that a State poster be displayed. In such States, it may be adequate to display only a State poster. For further information about such requirements, consult any of the OSHA offices or the State statistical grant agencies (addresses and telephone numbers appear on pages 5 and 6). The order form which appears on the inside back cover of this booklet may be used to order posters. Employers using the form will be supplied with all necessary posters, including State posters, when they must be used in addition to the Federal poster.

Access to Records

Records can be inspected and copied at any reasonable time by authorized Federal or State government representatives.

Reporting of Fatality or Multiple Hospitalization Accidents

An employer must report any accident which results in one (1) or more deaths or in hospitalization of five (5) or more employees. The report must be made within 48 hours after the accident and can be made orally or in writing. It must be made to the Area Director of the Occupational Safety and Health Administration (see addresses and telephone numbers on page 5), except for States with approved State plans. In States which have approved plans, the report shall be made to the State agency which has enforcement responsibilities under the plan. Further information may be obtained from the OSHA Area Director.

Periodic Reports of Injuries and Illnesses

If an establishment is selected to participate in a survey of occupational injuries and illnesses, it will be mailed a report form at the proper time.

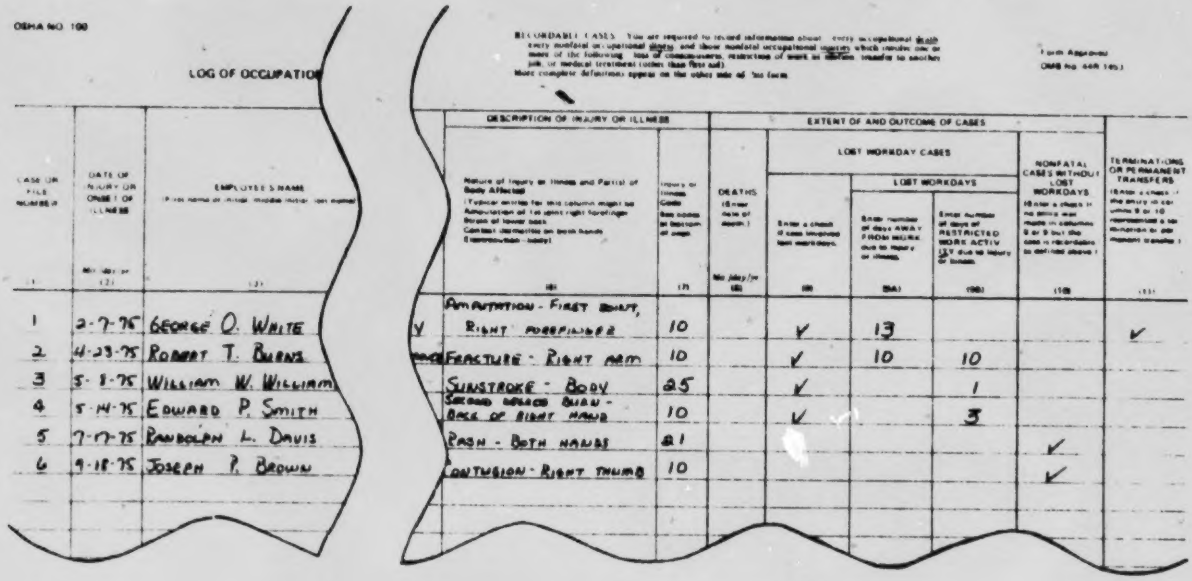
Where to Obtain OSHA Recordkeeping Forms

Recordkeeping forms will not be automatically mailed to employers each year. To request additional forms, use the order blank on the inside back cover of this booklet.

Recordkeeping Under Workmen's Compensation and OSHA

OSHA recordkeeping and reporting requirements differ from those established under the various State workmen's compensation laws. Because they differ, employers must not substitute workmen's compensation criteria in determining whether or not a case should be recorded for OSHA. Workmen's compensation rules may require employers to record more or fewer cases than the OSHA rules. For example, workmen's compensation laws in some States require an injury to be reported only if it results in at least two (2) lost workdays. In other States, any injury which requires a visit to a doctor must be reported, regardless of its severity. These examples differ from the OSHA definition of a recordable case. Employers which are using State first report forms as a substitute for the supplementary record (OSHA No. 101) must prepare a form for each OSHA recordable case whether or not the State workmen's compensation law requires that a report be prepared.

EXAMPLES OF COMPLETED RECORDKEEPING FORMS



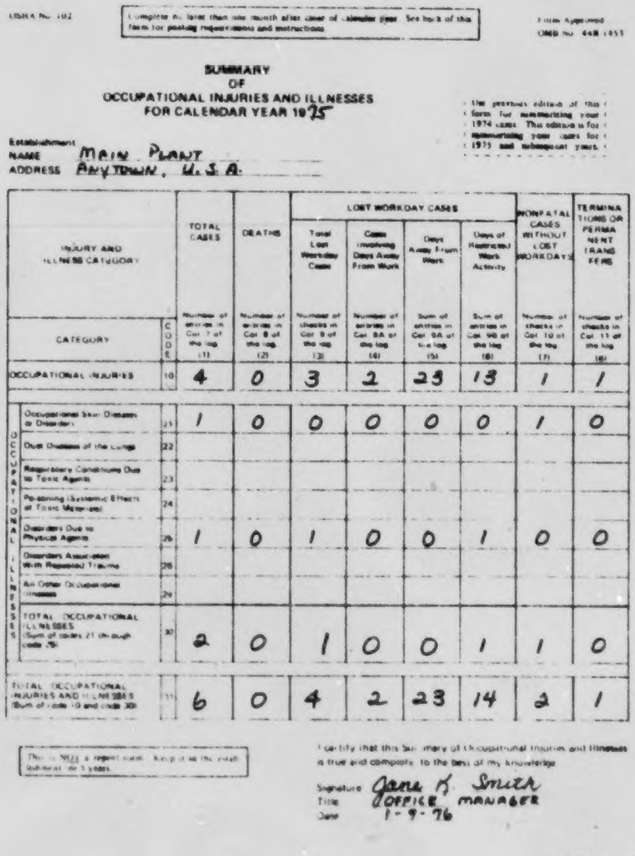
OSHA NO. 100

LOG OF OCCUPATIO

RECORDABLE CASES: You are required to record information about: every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). More complete definitions appear on the other side of this form.

Form Approved
OMB No. 44R 1453

CASE OR FILE NUMBER (1)	DATE OF INJURY OR ONSET OF ILLNESS Mo./day/yr. (2)	EMPLOYEE'S NAME (First name or initial, middle initial, last name) (3)	DESCRIPTION OF INJURY OR ILLNESS: Nature of Injury or Illness and Part(s) of Body Affected (Typical entries for this column might be: Amputation of 1st joint right forefinger; Strain of lower back; Contact dermatitis on both hands; Electrocution—body) (6)	Injury or Illness Code (See codes at bottom of page) (7)	DEATHS (Enter date of death.) Mo./day/yr. (8)	LOST WORKDAY CASES: Enter a check if case involved lost workdays. (9)	LOST WORKDAYS: Enter number of days AWAY FROM WORK due to injury or illness. (9A)	LOST WORKDAYS: Enter number of days of RESTRICTED WORK ACTIVITY due to injury or illness. (9B)	NONFATAL CASES WITHOUT LOST WORKDAYS (Enter a check if no entry was made in columns 8 or 9 but the case is recordable as defined above.) (10)	TERMINATIONS OR PERMANENT TRANSFERS (Enter a check if the entry in columns 9 or 10 represented a termination or permanent transfer.) (11)
1	2-7-75	GEORGE O. WHITE	AMPUTATION - FIRST JOINT, RIGHT FOREFINGER	10		✓	13			✓
2	4-23-75	ROBERT T. BURNS	FRACTURE - RIGHT ARM	10		✓	10	10		
3	5-8-75	WILLIAM W. WILLIAM	SUNSTROKE - BODY	25		✓		1		
4	5-14-75	EDWARD P. SMITH	SECOND DEGREE BURN - BACK OF RIGHT HAND	10		✓		3		
5	7-17-75	RANDOLPH L. DAVIS	RASH - BOTH HANDS	21					✓	
6	9-18-75	JOSEPH P. BROWN	CONTUSION - RIGHT THUMB	10					✓	



OSHA No. 102

Complete no later than one month after close of calendar year. See back of this form for posting requirements and instructions.

Form Approved
OMB No. 44R 1453

SUMMARY
OF
OCCUPATIONAL INJURIES AND ILLNESSES
FOR CALENDAR YEAR 1975

(The previous edition of this form for summarizing your 1974 cases. This edition is for summarizing your cases for 1975 and subsequent years.)

Establishment
NAME MAIN PLANT
ADDRESS ANYTOWN, U.S.A.

INJURY AND ILLNESS CATEGORY	CODE	TOTAL CASES (Number of entries in Col. 7 of the log) (1)	DEATHS (Number of entries in Col. 8 of the log) (2)	LOST WORKDAY CASES: Total Lost Workday Cases (Number of checks in Col. 9 of the log) (3)	Cases Involving Days Away From Work (Number of entries in Col. 9A of the log) (4)	Days Away From Work (Sum of entries in Col. 9A of the log) (5)	Days of Restricted Work Activity (Sum of entries in Col. 9B of the log) (6)	NONFATAL CASES WITHOUT LOST WORKDAYS (Number of checks in Col. 10 of the log) (7)	TERMINATIONS OR PERMANENT TRANSFERS (Number of checks in Col. 11 of the log) (8)
OCCUPATIONAL INJURIES	10	4	0	3	2	23	13	1	1
OCCUPATIONAL ILLNESSES: Occupational Skin Diseases or Disorders	21	1	0	0	0	0	0	1	0
Dust Diseases of the Lungs	22								
Respiratory Conditions Due to Toxic Agents	23								
Poisoning (Systemic Effects of Toxic Materials)	24								
Disorders Due to Physical Agents	25	1	0	1	0	0	1	0	0
Disorders Associated With Repeated Trauma	26								
All Other Occupational Illnesses	29								
TOTAL OCCUPATIONAL ILLNESSES (Sum of codes 21 through code 29)	30	2	0	1	0	0	1	1	0
TOTAL OCCUPATIONAL INJURIES AND ILLNESSES (Sum of code 10 and code 30)	31	6	0	4	2	23	14	2	1

This is NOT a report form. Keep it in the establishment for 5 years.

I certify that this Summary of Occupational Injuries and Illnesses is true and complete to the best of my knowledge.

Signature Jane K. Smith
Title OFFICE MANAGER
Date 1-9-76

The sample summary at left was prepared using the cases from the log above as follows.

The first line (code 10) of the summary is used to record injuries. These are identified on the log by a code 10 in column 7.

Col. 1. Total Cases: Four cases involved injuries (identified by a code 10 in column 7 of the log).

Col. 2. Deaths. There were no deaths (no entries in column 8 of the log).

Col. 3. Total Lost Workday Cases. Three of the four injury cases had a check in column 9 of the log

Col. 4. Cases Involving Days Away From Work. Two of the four injury cases had an entry in column 9A of the log.

Col. 5. Days Away From Work. The two injury cases which had entries in column 9A of the log had a total of 23 days away from work.

Col. 6. Days of Restricted Work Activity. The two injury cases which had entries in column 9B of the log involved a total of 13 days of restricted work activity.

Col. 7. Nonfatal Cases Without Lost Workdays. One injury case had a check in column 10 of the log.

Col. 8. Terminations or Permanent Transfers: One injury case had a check in column 11 of the log.

CHECK. The sum of columns 2, 3, and 7 should equal the number entered in column 1. It does.

The same procedure is used to summarize each occupational illness category. There are entries on the lines for codes 21 and 25 because these codes were used in column 7 of the log to record the two illness cases.

On the line for code 30, Total - Occupational Illnesses, the sum of the entries for codes 21 through 29 were entered.

The totals for all occupational injuries and illnesses were entered on the line for code 31. The entries for codes 10 and 30 were added to arrive at these totals.

SUPPLEMENTARY RECORD OF OCCUPATIONAL INJURIES AND ILLNESSES

To supplement the Log of Occupational Injuries and Illnesses (OSHA No. 100), each establishment must maintain a record of each recordable occupational injury or illness. Workmen's compensation, insurance, or other reports are acceptable as records if they contain all facts listed below or are supplemented to do so. If no suitable report is made for other purposes, this form (OSHA No. 101) may be used or the necessary facts can be listed on a separate plain sheet of paper. These records must also be available in the establishment without delay and at reasonable times for examination by representatives of the Department of Labor and the Department of Health, Education and Welfare, and States accorded jurisdiction under the Act. The records must be maintained for a period of not less than five years following the end of the calendar year to which they relate.

Such records must contain at least the following facts:

1) *About the employer*—name, mail address, and location if different from mail address.

2) *About the injured or ill employee*—name, social security number, home address, age, sex, occupation, and department.

3) *About the accident or exposure to occupational illness*—place of accident or exposure, whether it was on employer's premises, what the employee was doing when injured, and how the accident occurred.

4) *About the occupational injury or illness*—description of the injury or illness, including part of body affected; name of the object or substance which directly injured the employee; and date of injury or diagnosis of illness.

5) *Other*—name and address of physician; if hospitalized, name and address of hospital; date of report; and name and position of person preparing the report.

SEE *DEFINITIONS* ON THE BACK OF OSHA FORM 100.

OSHA No. 101
Case or File No. ____________

Form approved
OMB No. 44R 1453

Supplementary Record of Occupational Injuries and Illnesses

EMPLOYER

1. Name ____
2. Mail address ____
(No. and street) (City or town) (State)
3. Location, if different from mail address ____

INJURED OR ILL EMPLOYEE

4. Name ______________________ Social Security No. ______________
(First name) (Middle name) (Last name)
5. Home address ____
(No. and street) (City or town) (State)
6. Age ____________ 7. Sex: Male____________ Female____________ (Check one)
8. Occupation ____
(Enter regular job title, *not* the specific activity he was performing at time of injury.)
9. Department ____
(Enter name of department or division in which the injured person is regularly employed, even though he may have been temporarily working in another department at the time of injury.)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure ____
(No. and street) (City or town) (State)
If accident or exposure occurred on employer's premises, give address of plant or establishment in which it occurred. Do not indicate department or division within the plant or establishment. If accident occurred outside employer's premises at an identifiable address, give that address. If it occurred on a public highway or at any other place which cannot be identified by number and street, please provide place references locating the place of injury as accurately as possible.
11. Was place of accident or exposure on employer's premises? ______________ (Yes or No)
12. What was the employee doing when injured? ____
(Be specific. If he was using tools or equipment or handling material,
____
name them and tell what he was doing with them.)
____
13. How did the accident occur? ____
(Describe fully the events which resulted in the injury or occupational illness. Tell what
____
happened and how it happened. Name any objects or substances involved and tell how they were involved. Give
____
full details on all factors which led or contributed to the accident. Use separate sheet for additional space.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

14. Describe the injury or illness in detail and indicate the part of body affected. ____________________
(e.g.: amputation of right index finger
____
at second joint; fracture of ribs; lead poisoning; dermatitis of left hand, etc.)
15. Name the object or substance which directly injured the employee. (For example, the machine or thing he struck against or which struck him; the vapor or poison he inhaled or swallowed; the chemical or radiation which irritated his skin; or in cases of strains, hernias, etc., the thing he was lifting, pulling, etc.)
____
____
16. Date of injury or initial diagnosis of occupational illness ____________________________
(Date)
17. Did employee die? ____________ (Yes or No)

OTHER

18. Name and address of physician ____
19. If hospitalized, name and address of hospital ____
____

Date of report ________________ Prepared by ____
Official position ________________________

LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

Each employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must maintain for each establishment a log of all recordable occupational injuries and illnesses. This form (OSHA No. 100) may be used for that purpose. A substitute for the OSHA No. 100 is acceptable if it is as detailed, easily readable and understandable as the OSHA No. 100.

Each recordable occupational injury and occupational illness must be timely entered on the log. Logs must be kept current and retained for five (5) years following the end of the calendar year to which they relate. Logs must be available (normally at the establishment) for inspection and copying by representatives of the Department of Labor, or the Department of Health, Education and Welfare, or States accorded jurisdiction under the Act.

INSTRUCTIONS FOR COMPLETING LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

Column 1 - CASE OR FILE NUMBER

Enter a number which will facilitate comparison with supplementary records. Any series of nonduplicating numbers may be used.

Column 2 - DATE OF INJURY OR ONSET OF ILLNESS

For occupational injuries enter the date of the work accident which resulted in injury. For occupational illnesses enter the date of initial diagnosis of illness, or, if absence from work occurred before diagnosis, enter the first day of the absence attributable to the illness which was later diagnosed or recognized.

Column 3 - EMPLOYEE'S NAME

Column 4 - OCCUPATION

Enter regular job title, not the specific activity being performed at time of injury or illness. In the absence of a formal occupational title, enter a brief description of the duties of the employee.

Column 5 - DEPARTMENT

Enter the name of the department or division in which the injured person is regularly employed, even though temporarily working in another department at the time of injury or illness. In the absence of formal department titles, enter a brief description of normal workplace to which employee is assigned

Column 6 - NATURE OF INJURY OR ILLNESS AND PART(S) OF BODY AFFECTED

Enter a brief description of the injury or illness and indicate the part or parts of body affected. Where entire body is affected, the entry "body" can be used.

Column 7 - INJURY OR ILLNESS CODE

Enter the one code which most accurately describes the case. A list of the codes appears at the bottom of the log. A more complete description of recordable occupational injuries and illnesses appears in "DEFINITIONS."

Column 8 - DEATHS

If the occupational injury or illness resulted in death, enter date of death.

Column 9 - LOST WORKDAY CASES

Enter a check for each case which involves days away from work, or days of restricted work activity, or both. Each lost workday case also requires an entry in column 9A or column 9B, or both.

Column 9A - LOST WORKDAYS–DAYS AWAY FROM WORK

Enter the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

NOTE: For employees not having a regularly scheduled shift., i.e., certain truck drivers, construction workers, farm labor, casual labor, part-time employees, etc., it may be necessary to estimate the number of lost workdays. Estimates of lost workdays shall be based on prior work history of the employee AND days worked by employees, not ill or injured, working in the department and/or occupation of the ill or injured employee.

Column 9B - LOST WORKDAYS--DAYS OF RESTRICTED WORK ACTIVITY

Enter the number of workdays (consecutive or not) on which because of injury or illness:

1) the employee was assigned to another job on a temporary basis, or
2) the employee worked at a permanent job less than full time, or
3) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

Column 10 - NONFATAL CASES WITHOUT LOST WORKDAYS

Enter a check for any recordable case which does not involve a fatality or lost workdays.

Column 11 - TERMINATIONS OR PERMANENT TRANSFERS

Enter a check if the entry in columns 9 or 10 represented a termination of employment or permanent transfer.

OSHA NO. 100

LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

CASE OR FILE NUMBER (1)	DATE OF INJURY OR ONSET OF ILLNESS Mo./day/yr. (2)	EMPLOYEE'S NAME (First name or initial, middle initial, last name) (3)	OCCUPATION (Enter regular job title, not activity employee was performing when injured or at onset of illness.) (4)	DEPARTMENT (Enter department in which the employee is regularly employed.) (5)	DE Nature o Body A (Typical Amputat Strain of Contact Electroc

Company Name ____________________
Establishment Name ____________________
Establishment Address ____________________

NOTE: This is NOT a report form. Keep it in the establishment for 5 years.

14-30

RECORDABLE CASES: You are required to record information about: every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid).
More complete definitions appear on the other side of this form.

Form Approved
OMB No. 44R 1453

RIPTION OF INJURY OR ILLNESS		EXTENT OF AND OUTCOME OF CASES					
			LOST WORKDAY CASES				
				LOST WORKDAYS			
njury or Illness and Part(s) of tad tries for this column might be: n of 1st joint right forefinger wer back matitis on both hands on—body) (6)	Injury or Illness Code See codes at bottom of page. (7)	DEATHS (Enter date of death.) *Mo./day/yr.* (8)	Enter a check if case involved lost workdays. (9)	Enter number of days AWAY FROM WORK due to injury or illness. (9A)	Enter number of days of RESTRICTED WORK ACTIV ITY due to injury or illness. (9B)	NONFATAL CASES WITHOUT LOST WORKDAYS (Enter a check if no entry was made in columns 8 or 9 but the case is recordable, as defined above.) (10)	TERMINATIONS OR PERMANENT TRANSFERS (Enter a check if the entry in columns 9 or 10 represented a termination or permanent transfer.) (11)

Injury Code
10 All occupational injuries
Illness Codes

21 Occupational skin diseases or disorders
22 Dust diseases of the lungs (pneumoconioses)
23 Respiratory conditions due to toxic agents
24 Poisoning (systemic effects of toxic materials)
25 Disorders due to physical agents (other than toxic materials)
26 Disorders associated with repeated trauma
29 All other occupational illnesses

CHANGES IN EXTENT OF OR OUTCOME OF INJURY OR ILLNESS

If, during the 5-year period the log must be retained, there is a change in a case which affects entries in columns 9 or 10, the first entry should be lined out and a new entry made. For example, if an injured employee at first required only medical treatment but later lost workdays, the check in column 10 should be lined out, a check entered in column 9, and the number of lost workdays entered in columns 9A and/or 9B.

In another example, if an employee with an occupational illness lost workdays, returned to work, and then died of the illness, the entries in columns 9, 9A, and/or 9B should be lined out and the date of death entered in column 8.

The entire entry for a case should be lined out if the case is later found to be nonrecordable. Examples are: A case which is later determined not to be work related, or a case which was initially thought to involve medical treatment but later was determined to have involved only first aid.

DEFINITIONS

RECORDABLE OCCUPATIONAL INJURIES AND ILLNESSES are:

1) OCCUPATIONAL DEATHS, regardless of the time between injury and death, or the length of the illness; or

2) OCCUPATIONAL ILLNESSES; or

3) OCCUPATIONAL INJURIES which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid.)

NOTE: Any case which involves lost workdays must be recorded since it always involves one or more of the criteria for recordability.

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, amputation, etc., which results from a work accident or from an exposure involving a single incident in the work environment.

NOTE: Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact.

The following listing gives the categories of occupational illnesses and disorders that will be utilized for the purpose of classifying recordable illnesses. The identifying codes are those to be used in column 7 of the log. For purposes of information, examples of each category are given. These are typical examples, however, and are not to be considered to be the complete listing of the types of illnesses and disorders that are to be counted under each category.

(21) Occupational Skin Diseases or Disorders
Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants; oil acne; chrome ulcers; chemical burns or inflammations; etc.

(22) Dust Diseases of the Lungs (Pneumoconioses)
Examples: Silicosis, asbestosis, coal worker's pneumoconiosis, byssinosis, and other pneumoconioses.

(23) Respiratory Conditions Due to Toxic Agents
Examples: Pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes; farmer's lung; etc.

(24) Poisoning (Systemic Effects of Toxic Materials)
Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals, poisoning by carbon monoxide, hydrogen sulfide or other gases, poisoning by benzol, carbon tetrachloride, or other organic solvents; poisoning by insecticide sprays such as parathion, lead arsenate; poisoning by other chemicals such as formaldehyde, plastics and resins; etc.

(25) Disorders Due to Physical Agents (Other Than Toxic Materials)
Examples: Heatstroke, sunstroke, heat exhaustion and other effects of environmental heat; freezing, frostbite and effects of exposure to low temperatures; caisson disease; effects of ionizing radiation (isotopes, X-rays, radium); effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn); etc.

(26) Disorders Associated With Repeated Trauma
Examples: Noise-induced hearing loss, synovitis, tenosynovitis, and bursitis; Raynaud's phenomena; and other conditions due to repeated motion, vibration or pressure.

(29) All Other Occupational Illnesses
Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumors, food poisoning, histoplasmosis, coccidioidomycosis, etc.

MEDICAL TREATMENT includes treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does NOT include first aid treatment (one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care) even though provided by a physician or registered professional personnel.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed (for example: a factory, mill, store, hotel, restaurant, movie theater, farm, ranch, bank, sales office, warehouse, or central administrative office). Where distinctly separate activities are performed at a single physical location (such as contract construction activities operated from the same physical location as a lumber yard), each activity shall be treated as a separate establishment.

For firms engaged in activities such as agriculture, construction, transportation, communications, and electric, gas and sanitary services, which may be physically dispersed, records may be maintained at a place to which employees report each day.

Records for personnel who do not primarily report or work at a single establishment, such as traveling salesmen, technicians, engineers, etc., shall be maintained at the location from which they are paid or the base from which personnel operate to carry out their activities.

WORK ENVIRONMENT is comprised of the physical location, equipment, materials processed or used, and the kinds of operations performed by an employee in the performance of his work, whether on or off the employer's premises.

OSHA No. 102

Complete no later than one month after close of calendar year. See back of this form for posting requirements and instructions.

Form Approved
OMB No. 44R 1453

SUMMARY
OF
OCCUPATIONAL INJURIES AND ILLNESSES
FOR CALENDAR YEAR 19 __

Use previous edition of this form for summarizing your 1974 cases. This edition is for summarizing your cases for 1975 and subsequent years.

Establishment:
NAME ____________________
ADDRESS ____________________

INJURY AND ILLNESS CATEGORY		TOTAL CASES	DEATHS	LOST WORKDAY CASES				NONFATAL CASES WITHOUT LOST WORKDAYS	TERMINATIONS OR PERMANENT TRANSFERS
				Total Lost Workday Cases	Cases Involving Days Away From Work	Days Away From Work	Days of Restricted Work Activity		
CATEGORY	CODE	Number of entries in Col. 7 of the log. (1)	Number of entries in Col. 8 of the log. (2)	Number of checks in Col. 9 of the log. (3)	Number of entries in Col. 9A of the log. (4)	Sum of entries in Col. 9A of the log. (5)	Sum of entries in Col. 9B of the log. (6)	Number of checks in Col. 10 of the log. (7)	Number of checks in Col. 11 of the log. (8)
OCCUPATIONAL INJURIES	10								
OCCUPATIONAL ILLNESSES									
Occupational Skin Diseases or Disorders	21								
Dust Diseases of the Lungs	22								
Respiratory Conditions Due to Toxic Agents	23								
Poisoning (Systemic Effects of Toxic Materials)	24								
Disorders Due to Physical Agents	25								
Disorders Associated With Repeated Trauma	26								
All Other Occupational Illnesses	29								
TOTAL - OCCUPATIONAL ILLNESSES (Sum of codes 21 through code 29)	30								
TOTAL - OCCUPATIONAL INJURIES AND ILLNESSES (Sum of code 10 and code 30)	31								

This is NOT a report form. Keep it in the establishment for 5 years.

I certify that this Summary of Occupational Injuries and Illnesses is true and complete, to the best of my knowledge.

Signature ____________________
Title ____________________
Date ____________________

SUMMARY OF OCCUPATIONAL INJURIES AND ILLNESSES

Every employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must use this form to prepare an annual summary of the occupational injury and illness experience of the employees in each of his establishments within one month following the end of each year.

POSTING REQUIREMENTS: A copy or copies of the summary must be posted at each establishment in the place or places where notices to employees are customarily posted. This summary must be posted no later than February 1 and must remain in place until March 1.

INSTRUCTIONS for completing this form: All entries must be summarized from the log (OSHA No. 100) or its equivalent. Before preparing this summary, review the log to be sure that entries are correct and each case is included in only one of the following classes: deaths (date in column 8), lost workday cases (check in column 9), or nonfatal cases without lost workdays (check in column 10). If an employee's loss of workdays is continuing at the time the summary is being made, estimate the number of future workdays he will lose and add that estimate to the workdays he has already lost and include this total in the summary. No further entries are to be made with respect to such cases in the next year's summary.

Occupational injuries and the seven categories of occupational illnesses are to be summarized separately. Identify each case by the code in column 7 of the log of occupational injuries and illnesses.

The summary from the log is made as follows:

A. For occupational injuries (identified by a code 10 in column 7 of the log form) make entries on the line for code 10 of this form.

Column 1 – Total Cases. Count the number of entries which have a code 10 in column 7 of the log. Enter this total in column 1 of this form. This is the total of occupational injuries for the year.
Column 2 – Deaths. Count the number of entries (date of death) for occupational injuries in column 8 of the log.
Column 3 – Total Lost Workday Cases. Count the number of checks for occupational injuries in column 9 of the log.
Column 4 – Cases Involving Days Away From Work. Count the number of entries for occupational injuries in column 9A of the log.
Column 5 – Days Away From Work. Add the entries (total days away) for occupational injuries in column 9A of the log.
Column 6 – Days of Restricted Work Activity. Add the entries (total of such days) for occupational injuries in column 9B of the log.
Column 7 – Nonfatal Cases Without Lost Workdays. Count the number of checks for occupational injuries in column 10 of the log.
Column 8 – Terminations or Permanent Transfers. Count the number of checks for occupational injuries in column 11 of the log.
CHECK: If the totals for code 10 have been entered correctly, the sum of columns 2, 3, and 7 will equal the number entered in column 1.

B. Follow the same procedure for each illness code, entering the totals on the appropriate line of this form.

C. Add the entries for codes 21 through 29 in each column for occupational illnesses and enter totals on the line for code 30.

D. Add the entries for codes 10 and 30 in each column and enter totals on the line for code 31.

CHECK: If the summary has been made correctly, the entry in column 1 of the total line (code 31) of this form will equal the total number of cases on the log.

The person responsible for the preparation of the summary shall certify that it is true and complete by signing the statement on the form.

Use previous edition of this form for summarizing your 1974 cases. This edition is for summarizing your cases for 1975 and subsequent years. Forms for the 1974 summary can be obtained from the appropriate State statistical grant agency (if there is one in your State) or from the appropriate Regional Office of the Bureau of Labor Statistics. Addresses are in the booklet entitled Recordkeeping Requirements under the Occupational Safety and Health Act of 1970.

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Boston, Massachusetts 02110
Phone: 617-223-6712

Area Offices:

450 Main Street – Rm. 617
Hartford, Connecticut 06103
Phone: 203-244-2294

Custom House Building, State Street
Boston, Massachusetts 02109
Phone: 617-223-4511

55 Pleasant Street – Rm. 426
Concord, New Hampshire 03301
Phone: 603-224-1995

436 Dwight Street – Rm. 501
Springfield, Massachusetts 01103
Phone: 413-781-2420

Region II: New York, New Jersey, Puerto Rico, Virgin Islands, Canal Zone
1515 Broadway
New York, New York 10036
Phone: 212-971-5921

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970 Broad Street – Rm. 1435C
Newark, New Jersey 07102
Phone: 201-645-5930

370 Old Country Road
Garden City, L.I., New York 11530
Phone: 516-294-0400

90 Church Street – Rm. 1405
New York, New York 10007
Phone: 212-264-9840

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Phone: 301-962-2840

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4099 William Penn Highway
Monroeville, Pennsylvania 15146
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600 Arch Street – Suite 4456
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Fort Lauderdale, Florida 33308
Phone 305-735-6606 X331

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Building 10
Tucker, Georgia 30384
Phone: 404-939-8987

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Macon, Georgia 31204
Phone: 912-746-5143

6605 Abercorn Street – Suite 204
Savannah, Georgia 31405
Phone: 912-345-0733

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Louisville, Kentucky 40202
Phone: 502-582-6111

2809 Art Museum Drive – Suite 4
Jacksonville, Florida 32207
Phone: 904-791-2895

310 New Bern Ave. – Rm. 378
Raleigh, North Carolina 27601
Phone: 919-755-4770

1710 Gervais Street – Rm. 205
Columbia, South Carolina 29201
Phone: 803-765-5904

5760 I-55 No. Frontage Rd. East
Jackson, Mississippi 39200
Phone: 601-969-4606

1600 Hayes Street – Suite 302
Nashville, Tennessee 37203
Phone: 615-749-5313

Region V: Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin
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Phone: 312-353-4716

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Chicago, Illinois 60604
Phone: 312-353-1390

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Indianapolis, Indiana 46204
Phone: 317-633-7384

220 Bagley Avenue – Rm. 626
Detroit, Michigan 48226
Phone: 313-226-6720

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Minneapolis, Minnesota 55401
Phone: 612-725-2571

550 Main Street – Rm. 4028
Cincinnati, Ohio 45202
Phone: 513-684-2355

1240 East Ninth Street – Rm. 847
Cleveland, Ohio 44199
Phone: 216-522-3818

360 So. Third Street – Rm. 109
Columbus, Ohio 43215
Phone: 614-469-5582

234 N. Summit Street – Rm. 734
Toledo, Ohio 43604
Phone: 419-259-7542

633 W. Wisconsin Ave. – Rm. 400
Milwaukee, Wisconsin 53203
Phone: 414-224-1030

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Phone: 501-378-6192

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Phone: 504-527-2451

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San Antonio, Texas 78213
Phone: 512-225-5511 Ext. 4591

420 South Boulder – Rm. 514
Tulsa, Oklahoma 74103
Phone: 918-581-7676

1412 Main Street – Suite 1820
Dallas, Texas 75202
Phone: 214-749-1786

2320 LaBranch Street – Rm. 2118
Houston, Texas 77004
Phone: 713-226-5431

1205 Texas Avenue – Rm. 421
Lubbock, Texas 79401
Phone: 806-762-7681

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P.O. Box 1428
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Phone: 505-766-3411

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Kansas City, Missouri 64106
Phone: 816-374-5861

Area Offices:

1627 Main Street – Rm. 1100
Kansas City, Missouri 64108
Phone: 816-374-2756

210 North 12th Boulevard – Rm. 554
St. Louis, Missouri 63101
Phone: 314-622-5461

16th and Harney Street
City National Bank Building – Rm. 803
Omaha, Nebraska 68102
Phone: 402-221-3276

221 South Broadway Street – Suite 312
Wichita, Kansas 67202
Phone: 316-267-6311 Ext 644

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Denver, Colorado 80202
Phone: 303-837-3883

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Phone: 303-234-4471

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Salt Lake City, Utah 84111
Phone: 801-524-5080

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San Francisco, California 94102
Phone: 415-556-0536

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Honolulu, Hawaii 96813
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1100 East William Street – Suite 222
Carson City, Nevada 89701
Phone: 702-883-1226

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506 Second Avenue – Rm. 1808
Seattle, Washington 98104
Phone: 206-442-5930

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Anchorage, Alaska 99501
Phone: 907-272-5561 Ext 851

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Portland, Oregon 97205
Phone: 503-221-2251

121 – 107th Avenue, N.E. – Rm. 110
Bellevue, Washington 98004
Phone: 206-442-7520

228 Idaho Building
Boise, Idaho 83702
Phone: 208-342-2711 Ext 2622

STATISTICAL GRANT AGENCIES

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2041 Canyon Road
Todd Mall
Birmingham, Alabama 35216
Phone: (205) 822-9352

Alaska Department of Labor
P.O. Box 3-7000
Juneau, Alaska 99801
Phone: (907) 586-6830

American Samoa Department of Manpower Resources
Pago Pago, American Samoa 96799
Phone: 633-6485

Industrial Commission of Arizona
P.O. Box 19070
Phoenix, Arizona 85005
Phone: (602) 271-4411

Arkansas Department of Labor
Capitol Hill Building
Little Rock, Arkansas 72201
Phone: (501) 371 1431

California Department of Industrial Relations
Division of Labor Statistics and Research
455 Golden Gate Avenue
San Francisco, California 94102
Phone: (415) 557 3317

Colorado Department of Labor and Employment
Division of Labor
200 E. 9th Avenue
Denver, Colorado 80203
Phone: (303) 573-0593

Connecticut Department of Labor
200 Folly Brook Boulevard
Wethersfield, Connecticut 06109
Phone: (203) 566-4380

District of Columbia Minimum Wage and
Industrial Safety Board
Industrial Safety Division
2900 Newton St. N.E.
Washington, D.C. 20018
Phone: (202) 832-1572

Delaware Department of Labor
Division of Industrial Affairs
618 No. Union Street
Wilmington, Delaware 19805
Phone: (302) 571 2879

Florida Department of Commerce
Ashley Building Rm. 202
1321 Executive Center Drive, East
Tallahassee, Florida 32301
Phone: (904) 488-5837

Guam Department of Labor
P.O. Box 2950
Agana, Guam 96910
Phone: 777-9823

Hawaii Department of Labor
and Industrial Relations
825 Mililani Street
Honolulu, Hawaii 96813
Phone: (808) 548-7638

Idaho Industrial Commission
Industrial Administration Building
317 Main Street
Boise, Idaho 83702
Phone: (208) 384 2193

Illinois Industrial Commission
160 North LaSalle Street
Chicago, Illinois 60601
Phone: (312) 793 5655

Indiana Division of Labor
1013 State Office Building
100 No. Senate Avenue
Indianapolis, Indiana 46204
Phone: (317) 633-4473

Iowa Bureau of Labor
State House
East 7th and Court
Des Moines, Iowa 50319
Phone: (515) 281 3606

Kansas Department of Health
Forbes Air Force Base
Building 740
Topeka, Kansas 66620
Phone: (913) 296 3523

Kentucky Department of Labor
Research and Statistics Division
Capitol Plaza Tower
Frankfort, Kentucky 40601
Phone: (502) 564-6605

Louisiana Department of Labor
P.O. Box 44063
1045 National Resources Building
Baton Rouge, Louisiana 70804
Phone: (504) 389-5314

Maine Department of Manpower Affairs
Bureau of Labor and Industry
Division of Research and Statistics
Augusta, Maine 04330
Phone: (207) 289-3331

Maryland Department of Licensing
and Regulation
Division of Labor and Industry
203 E. Baltimore Street
Baltimore, Maryland 21202
Phone: (301) 383-2264

Massachusetts Department of Labor and Industries
Division of Statistics
Leverett Saltonstall State Office Building
100 Cambridge Street
Boston, Massachusetts 02202
Phone: (617) 727-3593

Michigan Department of Labor
300 E. Michigan Avenue
Lansing, Michigan 48926
Phone: (517) 373-3566

Minnesota Department of Labor and Industry
444 Lafayette Road
St. Paul, Minnesota 55101
Phone: (612) 296-4893

Mississippi State Board of Health
Division of Occupational Safety and Health
2628 Southerland Street
Jackson, Mississippi 39216
Phone: (601) 982-6315

Missouri Division of Workmen's Compensation
P.O. Box 449
Jefferson City, Missouri 65101
Phone: (314) 751-4231

Montana Department of Labor and Industry
Workmen's Compensation Division
815 Front Street
Helena, Montana 59601
Phone: (406) 449-3182

Nebraska Workmen's Compensation Court
Capitol Building 13th Floor
Lincoln, Nebraska 68509
Phone: (402) 471 2568

New Hampshire Department of Labor
1 Pillsbury Street
Concord, New Hampshire 03301
Phone: (603) 271 3176

New Jersey Department of Labor and Industry
P.O. Box 2765
Trenton, New Jersey 08625
Phone: (609) 292 8997

New Mexico Health and Social Services Department
Environmental Improvement Agency
Occupational Health and Safety Section
P.O. Box 2348
Santa Fe, New Mexico 87501
Phone: (505) 827-5273

New York State Department of Labor
Division of Research and Statistics
2 World Trade Center
New York, New York 10047
Phone: (212) 488-4661

North Carolina Department of Labor
Division of Statistics
P.O. Box 27407
Raleigh, North Carolina 27611
Phone: (919) 829-4940

North Dakota Workmen's Compensation Bureau
Statistical Department — 9th Floor
State Capitol
Bismark, North Dakota 58501
Phone: (701) 224-2700 Ext. 9

Ohio Department of Industrial Relations
OSHA Survey Operations
P.O. Box 12355
Columbus, Ohio 43212
Phone: (614) 466-7520

Oklahoma Department of Health
Division of Public Health and Statistics
10th and Stonewall
P.O. Box 53551
Oklahoma City, Oklahoma 73105
Phone: (405) 271 4542

Oregon Workmen's Compensation Board
Planning and Research
2111 Front, N.E.
Salem, Oregon 97310
Phone: (503) 378-8254

Pennsylvania Department of Labor and Industry
7th and Forster Streets
Harrisburg, Pennsylvania 17120
Phone: (717) 787-1918

Puerto Rico Department of Labor
Bureau of Labor Statistics
414 Barbosa Avenue
Hato Rey, Puerto Rico 00917
Phone: (809) 763-3827

Rhode Island Department of Labor
235 Promenade Street
Providence, Rhode Island 02908
Phone: (401) 277-2731

South Carolina Department of Labor
P.O. Box 11329
Columbia, South Carolina 29211
Phone: (803) 758-8507

South Dakota Department of Health
Division of Public Health Statistics
Pierre, South Dakota 57501
Phone: (605) 224-3355

Tennessee Department of Labor
Cordell Hull Building C1-125
Nashville, Tennessee 37219
Phone: (615) 741-1748

Texas Department of Health
Division of Occupational Safety
1100 West 49th Street
Austin, Texas 78756
Phone: (512) 454-3781

Utah Industrial Commission
158 Social Hall Avenue
Salt Lake City, Utah 84111
Phone: (801) 328-5688

Vermont Department of Labor and Industry
State Office Building
Montpelier, Vermont 05602
Phone: (802) 828-2286

Virgin Islands Department of Labor
P.O. Box [illegible]48
St. Thomas, Virgin Islands 00801
Phone: (809) 774-3650

Virginia Department of Labor and Industry
P.O. Box 1814
Ninth Street Office Building
Richmond, Virginia 23214
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Washington Department of Labor and Industries
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Olympia, Washington 98504
Phone: (206) 753-4013

West Virginia Department of Labor
Capitol Complex Building #6 - Rm. 437
Charleston, West Virginia 25305
Phone: (304) 348-7890

Wisconsin Department of Industry, Labor
and Human Relations
201 E. Washington Avenue
Madison, Wisconsin 53702
Phone: (608) 266-7559

Wyoming Department of Labor and Statistics
State Office Bldg. East — 3rd Floor
Cheyenne, Wyoming 82002
Phone: (307) 777 7261

UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS–REGIONAL OFFICES

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RECORDKEEPING AIDS

What Every Employer Needs to Know About OSHA Recordkeeping

A booklet containing answers to more than 160 questions frequently asked about recordkeeping. The order blank below may be used to request copies.

The Audio Aid to OSHA Recordkeeping

A package containing a cassette tape, the recordkeeping requirements booklet, and What Every Employer Needs to Know About OSHA Recordkeeping. Using the sample entries in the recordkeeping booklet as a guide, the tape gives a detailed explanation of how to correctly record work-related injuries and illnesses. Can be purchased at a cost of $5 from the National Audiovisual Center, Washington, D.C. 20409. Checks should be made payable to the National Archives Trust Fund.

NEED MORE RECORDKEEPING BOOKLETS OR FORMS?

Booklets and forms can be obtained by completing the order form below and mailing it to the appropriate State statistical grant agency (if there is one in your State) or to the nearest Regional Office of the Bureau of Labor Statistics.

ORDER FORM

From: Name ______________________________

Firm ______________________________

Street Address ______________________________

City and State ______________________________ ZIP ________

–Please send me the following items at no charge:

_____ Recordkeeping Booklets
_____ Log of Occupational Injuries and Illnesses (Form OSHA 100)
_____ Supplementary Record of Occupational Injuries and Illnesses (Form OSHA 101)
_____ Summary of Occupational Injuries and Illnesses (Form OSHA 102)
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To assist you with prompt, accurate shipping, I have typed or printed the address label below. Please use it in sending my order.

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PART III. WORKSHOP LESSONS

WORKSHOP ON SAFETY PROGRAM PLANNING NO. W-1

METHODS Practical Exercises and Discussion **LENGTH** 50 minutes

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PURPOSE

Provide opportunities to practice basic steps in program planning.

OBJECTIVES

Enable the trainee to ...

1) Identify needs and requirements for a safety program in his/her science courses.

2) Formulate objectives and evaluative measures for a safety program.

3) Describe activities and resources to implement a safety program.

SPECIAL TERMS

Enabling Objective
Management by Objectives (MBO)
Primary Goal
Secondary Goal
Terminal Objective

INSTRUCTOR MATERIALS

Lesson Plan
Appendicss B and C
School Documents for Program Planning (if available)
Local Telephone Directories (if available)
Chalkboard, Chalk, Eraser

TRAINEE MATERIALS

Lesson Plan (complete)
Appendices B and C (if possible)

CONTENTS

INTRODUCTION W-1-3

Directions W-1-4

EXERCISE 1 . . . . W-1-6

EXERCISE 2 . . . . W-1-7

EXERCISE 3 . . . . W-1-9

EXHIBITS

W-1-1. Responsibilities Under the OSH Act W-1-11

W-1-2. Occupational Safety and Health Regulations W-1-12

WORKSHEETS

W-1-1. Hazard Analysis W-1-13

W-1-2. Safety Program Objectives and Evaluation W-1-17

W-1-3. Safety Program Activities and Resources W-1-21

SUPPLEMENTS

Appendix B. Library Resources B-1

Appendix C. Directory of Resources C-1

312

LESSON Workshop on Safety Program Planning **NO.** W-1

NOTES	INSTRUCTION
	INTRODUCTION
Important!	Laboratory safety requires a continuous, comprehensive, and coordinated effort to be effective. Piecemeal attempt on a voluntary basis just won't do the job. Everybody must "get into the act" as a regular routine for safety programs to work.
	This workshop focuses on the planning aspects of a complete safety program for school science departments.
Important!	Administrative program planning may normally be done by the "higher ups" in many organizations including schools. However, safety program planning is at least one great exception to this rule. In industry, management and supervision do not have a safe workplace without employee participation. In schools, few if any administrators and department heads can have safe laboratories without teacher and student cooperation.
	Of course, in the classroom the teacher is the "manager" and the student is the "worker."
	Management education has been emphasizing objectives in recent years. This leadership

LESSON Workshop on Safety Program Planning NO. W-1

NOTES	INSTRUCTION
Management by Objectives (MBO)	style is known as Management by Objectives or MBO. The process is very similar to modern curriculum planning, so educators should feel at ease with it. Some schools may already be using MBO at the administrative level.
Important!	The essence of the process is simply to decide what an individual or work unit should accomplish (performance objectives) and then evaluate performance or achievement against stated goals. Of course, there is much more to program and curriculum planning than writing objectives. However, in MBO as in teacher-pupil planning, all levels are involved in the goal-setting.
Appendix B	The principles applied in this workshop should be useful in any planning situation. Support for worker (teacher and student) participation in safety program planning may be found throughout the literature on occupational safety and health.
Recommendations	Directions This workshop should be tackled as the climax of the In-Service Training Program. It should be introduced to teacher trainees as

LESSON Workshop on Safety Program Planning NO W-1

NOTES	INSTRUCTION
Final exam	such in the first lecture lesson (hence the label of Workshop W-1). It may be considered as the final exam for the course.
Important!	The workshop consists of 3 exercises to complete, preferably at least in part on the premises of the school science laboratory. Trainees may work individually or in groups. The results may be mailed to training supervisors, but group discussion is essential to the planning process as a whole.
Worksheets W-1-1, W-1-2 and W-1-3	Worksheets Each exercise contains a 4-page planning document. The completed set of worksheets makes up the basic plan for a safety program.
Exhibits W-1-1 and W-1-2	Exhibits The lesson plan contains 2 explanatory exhibits about the Federal Occupational Safety and Health Act.
State and local Regulations	State and local planning documents and legal requirements should also be used, if available.
Appendices B and C	Supplements Trainees should have copies of Appendices B and C, if possible.

LESSON Workshop on Safety Program Planning NO W-1

NOTES	INSTRUCTION

EXERCISE 1

Program planning usually begins with some expression of need. An actual problem requires a solution or a potential problem should be eliminated or controlled.

Basic need

Possibly nobody has been injured in your school science lab to date. However, the potential for serious injury-producing accidents exists in all laboratories, as the literature so amply illustrates. Therefore, the basic need is to prevent all injury-producing accidents in the school science laboratory.

But what is the nature and extent of safety and health hazards in your work area? What is already being done about them? What else should be done about them? What exactly are the needs and requirements for a safety program in your own laboratory?

The purpose of Exercise 1 is to find some answers to these questions.

The first 2 pages provide a chance to take stock of what is and the next 2 pages to record what should be. The latter also give examples.

NOTES	INSTRUCTION

EXERCISE 2

Having surveyed the hazard situation in your own domain, the next step in planning a safety program is to translate the needs and requirements into goals or objectives. You must also think of ways and means to measure success in achieving them.

Needs, goals, and objectives may mean the same or different things to you.

Using familiar educational terminology, let's call meeting our basic need the ultimate objective. Other primary needs or goals can be the terminal objectives. Then, secondary goals are like enabling objectives.

Constraints

But before you start writing, it might save time and effort in the long run to take a quick look at the ways these goal-setting and evaluative activities are now being done in your school. If there are constraints, you might as well get them on the table. And you should try to avoid making somebody else's mistake again or "reinventing the wheel."

The worksheet for Exercise 2 is designed to help accomplish all of the above and more. Again, examples are given to get you going.

LESSON Workshop on Safety Program Planning NO W-1

NOTES	INSTRUCTION
	Eventually, the program objectives and evaluative measures should be as specific as instructional objectives that include performance criteria. To save time now, however, simple action statements and means of evaluation will be enough.
Safety diagnosis	You should also keep in mind that program evaluation should not only measure achievement, but also point out weaknesses and areas for further improvement. In other words, evaluation is a diagnostic tool and safety program ills cannot be treated if they are ignored or denied.
Alternatives	The treatment of program problems will probably involve changes in the planning process sooner or later. The last part of Exercise 2 gives you a chance to practice making recommendations for this kind of change. If this is a sticky situation in your school, follow the procedures required in other kinds of administrative change. Or, if you prefer, recommend changes in the present modus operandi for completing this exercise.

LESSON Workshop on Safety Program Planning NO W-1

NOTES	INSTRUCTION
	EXERCISE 3
	The last exercise in this workshop gets down to the specifics of what to do and where to get help in implementing a safety program.
If you are a new teacher, use your experiences as a student.	First, look at where you are or where you have been. Jot down both success and failure, particularly in cases where you feel certain of the cause. These notes should make good reminders of what activities have or have not worked in the past, and why.
Appendices B and C	Next, plan major activities for yourself and your students. Try to utilize the resources suggested in Appendices B and C or others that you know of. The worksheet provides examples as clues.
Appendix C	Last, start your own directory of local resources, beginning with a search of the white and yellow pages for local branches of the national organizations listed in Appendix C.
	When you reach this point, you should have assembled and documented the beginnings of a real safety program for your science courses. Now is the time to go over all the

NOTES	INSTRUCTION
	exercises and worksheets to see if your planning documentation "hangs together." Try to fill in major gaps and supplement with explanatory notes that seem to be helpful.
	Next Steps
	Training supervisors will determine how your safety program plan is to be reviewed for completing the requirements of this program. Group meetings with open discussion are recom-
Important!	mended. The value of the workshop is in the planning process more than in the results.
	Whether or not there is a group session, you should try to get some feedback on your efforts from at least your colleagues and preferably your work supervisors, too.

EXHIBIT W-1-1. RESPONSIBILITIES UNDER THE OSH ACT

PL 91-596

the Occupational Safety and Health Act

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

5600 Fishers Lane,
Rockville, Md. 20852

> *"To assure safe and healthful working conditions for working men and women, by authorizing enforcement of the standards developed under the Act, by assisting and encouraging the States in their efforts to assure safe and healthful working conditions, by providing for research, information, education, and training in the field of occupational safety and health, and for other purposes."*
>
> **Public Law 91-596**

The Occupational Safety and Health Act of 1970 seeks to provide American workers with protection against personal injury and illness resulting from hazardous working conditions. Under its terms, the Federal Government is authorized to develop and set mandatory occupational safety and health standards applicable to any business affecting interstate commerce. The responsibility for promulgating and enforcing occupational safety and health standards rests with the Department of Labor.

The Department of Health, Education, and Welfare is responsible for conducting research on which new standards can be based, and for implementing education and training programs for producing an adequate supply of manpower to carry out the purposes of the Act. HEW's responsibilities are carried out by the National Institute for Occupational Safety and Health.

A 12-member National Advisory Committee on Occupational Safety and Health was also created by PL 91-596 to advise, consult and make recommendations to both the Secretaries of Labor and Health, Education, and Welfare. This Committee is composed of representatives of management, labor, occupational safety and health professions, and the public.

There is also a Presidentially appointed Occupational Safety and Health Review Commission which settles disputes arising from enforcement of the Act.

A National Commission on State Workmen's Compensation Laws was established to make a comprehensive study and evaluation of all work laws and report its findings to the President and the Congress by July 31, 1972.

HIGHLIGHTS OF AUTHORITIES UNDER PL 91-596:

Department of Labor

- To promulgate, modify and improve mandatory occupational safety and health standards.
- To enforce the Act, with authority to enter factories and other workplace areas to conduct inspections and investigations of working conditions, equipment and materials, and to issue citations and impose penalties.
- To prescribe regulations requiring employers to maintain accurate records and reports concerning work-related injury, illness and death, employee exposure to potentially toxic substances or other such records as considered appropriate, in cooperation with the Department of Health, Education, and Welfare.
- To develop and maintain a system of collecting, compiling and analyzing occupational safety and health statistics, in consultation with HEW.
- To establish and supervise programs for the education and training of employee and employer personnel in the recognition, avoidance and prevention of unsafe or unhealthful working conditions covered by the Act, in consultation with HEW.
- To make grants to States to assist in identifying their needs, for developing plans and to enforce the administration of the Federal occupational safety and health standards or equivalent State standards.

Department of Health, Education, and Welfare

- To develop criteria for the establishment of national occupational safety and health standards.
- To collect and analyze records and statistics on occupational safety and health necessary for promulgation of new or improved mandatory occupational safety and health standards.
- To conduct (directly or by grants or contracts) research or demonstrations relevant to occupational safety and health, including studies of behavioral and motivational factors.
- To develop criteria for dealing with toxic materials and harmful physical agents, indicating safe exposure levels for workers for various periods of time, in consultation with the Department of Labor.
- To make toxicity determinations on request by employer or employee groups.
- To publish an annual listing of all known toxic substances and the concentrations at which such toxicity is known to occur.
- To conduct directly or by grants and contracts educational and training programs aimed at providing an adequate supply of qualified personnel to carry out the purposes of the Act, and informational programs on the importance of and proper use of adequate safety and health equipment.

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control

EXHIBIT W-1-2. OCCUPATIONAL SAFETY AND HEALTH REGULATIONS

Regulations for implementing the Occupational Safety and Health Act of 1970 are contained in the Code of Federal Regulations, Title 29, Chapter XVII, Part 1910. The abbreviated citation is 29 CFR 1910.

The Code of Federal Regulations (CFR) is an annual codification of general and permanent rules published in the Federal Register by the Executive Departments and Agencies of the Federal Government.

The Federal Register is a daily supplement to the Code of Federal Regulations. Included are Presidential proclamations, executive orders, and reorganization plans, as well as regulations to implement public laws.

The Code is divided into 50 titles which represent broad areas that are subject to Federal regulation. Each title is divided into chapters which usually bear the name of the issuing agency. Each chapter is further subdivided into parts covering specific regulatory areas. Each part is divided into subparts containing the specific standards that may be applicable.

Subparts of 29 CFR 1910 are:

A - General
B - Adoption and Extension of Established Federal Standards
C - Reserved
D - Walking-Working Surfaces
E - Means of Egress
F - Powered Platforms, Manlifts and Vehicle-Mounted Work Platforms
G - Occupational Health and Environmental Control
H - Hazardous Materials
I - Personal Protective Equipment
J - General Environmental Controls
K - Medical and First Aid
L - Fire Protection
M - Compressed Gas and Compressed Air Equipment
N - Materials Handling and Storage
O - Machinery and Machine Guarding
P - Hand and Portable Powered Tools and Other Hand-Held Equipment
Q - Welding, Cutting and Brazing
R - Special Industries
S - Electrical

Federal regulations for occupational safety and health apply in states that do not have an approved plan that is equivalent to Federal standards.

WORKSHEET W-1-1. HAZARD ANALYSIS

Complete this page and the next 3 pages for your school or work area.

NAME ______________________________ DATE ______________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY ________________________ STATE ______________

---

1. Area of Concern (Use your own terminology for overall science safety.)

____

2. What potential safety and health hazards exist?

	Yes	No	?
a. Biological	___	___	___
b. Chemical	___	___	___
c. Electrical	___	___	___
d. Mechanical	___	___	___
e. Psychological	___	___	___
f. Radiological	___	___	___
g. Other (specify) ______________________	___	___	___

h. Most important of the above _______ (letter)

3. What means are available to measure and evaluate the above hazards and/or their effects?

	Yes	No	?
a. Conference or consultation with experts	___	___	___
b. Laboratory Analysis	___	___	___
c. Medical Records (staff and student)	___	___	___
d. Other Records and Reports	___	___	___
e. Research	___	___	___
f. Sampling	___	___	___
g. Site Surveys	___	___	___
h. Other (specify) ______________________	___	___	___

i. Most important of the above _______ (letter)

Worksheet W-1-1 (page 2 of 4) Name ______________________________

4. What means are now used to control the hazards and prevent accidents, injuries, and illnesses?

		Yes	No	?
a.	Administrative Directives	___	___	___
b.	Barriers, Guards, Shields	___	___	___
c.	Education, Training	___	___	___
d.	Housekeeping	___	___	___
e.	Labels, Signs	___	___	___
f.	Medical, First Aid	___	___	___
g.	Personal Protective Equipment	___	___	___
h.	Ventilation	___	___	___
i.	Work Practices	___	___	___
j.	Other (specify) ______________________________	___	___	___

k. Most important of the above _______ (letter)

5. Name or describe specific means of hazard control for which the "yes" column is checked in item 4 above.

Worksheet W-1-1 (page 3 of 4) 6. Needs Assessment Name ____________

Area of Concern	Equipment/Supplies	Education/Training	Other
Eye and Face Protection	Safety Goggles and Face Shields Eyewash Facilities	Use and Care Directions	Eye Protection Policy

Worksheet W-1-1 (page 4 of 4) 7. Requirements Review Name ____________________

Area of Concern	Federal Regulations	State Regulations	Other Standards
Eye and Face Protection	29 CFR 1910		ANSI Z87.1-1968

WORKSHEET W-1-2. SAFETY PROGRAM OBJECTIVES AND EVALUATION

Complete this page and the next 3 pages for your school or work area.

NAME ______________________________ DATE ______________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY _________________________ STATE ______________

1. What is the present modus operandi for defining program goals or objectives for safety and health in your school?

2. What is the present modus operandi for evaluating program success?

Worksheet W-1-2 (page 2 of 4)

3. Primary Goals

Name ______________________

Area of Concern	Terminal Objectives	Evidence of Achievement
Eye and Face Protection	Eliminate injury producing accidents in the lab.	Accident records and reports Absentee records and reports

Worksheet W-1-2 (page 3 of 4)   4. Secondary Goals   Name ____________________

Area of Concern	Enabling Objectives	Evidence of Achievement
Eye and Face Protection	All classroom participants will use proper protective devices.	Class records and reports

Name ______________________

5. What changes do you recommend in the present modus operandi for developing objectives and evaluative measures for science safety and health in your school?

   Include ways to involve students and parents. Also consider the use of safety and health professionals in the community as resources.

WORKSHEET W-1-3. SAFETY PROGRAM ACTIVITIES AND RESOURCES

Complete this and the next 3 pages for your school or work area.

NAME ______________________________ DATE ________________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY _________________________ STATE ______________

1. List your present or past activities dealing with laboratory safety.

   Draw from personal experience at home, if you have no lab safety experience.

2. What resources did you use for the above?

Worksheet W-1-3 (page 2 of 4) 3. Teacher Projects Name ____________________

Area of Concern	Activities	Resources
Eye and Face Protection	Prepare use and care directions for protective devices.	Associations (NSPB, etc.) Regulations (OSHA, etc.) Standards (ANSI, etc.) Suppliers Other Library References

Worksheet W-1-3 (page 3 of 4)   4. Student Projects   Name ____________

Area of Concern	Activities	Resources
Eye and Face Protection	Prepare personal checklist.	Regulations (OSHA, etc.) Standards (ANSI, etc.) Other Library References

Worksheet W-1-3 (page 4 of 4) Name ______________________

5. Local Directory of Resources

Check the telephone directory for associations, government agencies, and suppliers. Ask the Chamber of Commerce about businesses and industries that utilize safety and health professionals. Consult with local colleges and universities that offer programs in safety and health.

The following numbers should be posted in a conspicuous place in every science classroom and laboratory and on the teacher's desk.

Fire Department __________

Hospital __________

Poison Control __________

Police __________

Rescue Squad __________

WORKSHOP ON EYE AND FACE PROTECTION NO. W-5

METHODS Practical Exercises and Discussion **LENGTH** 50 minutes

PURPOSE Provide opportunities to practice identifying, evaluating, and controlling eye and face hazards in the laboratory.

OBJECTIVES Enable the trainee to ...

1) Identify types of exposure and means of evaluation and control for eye and face hazards in one's own laboratory.
2) Determine the teacher's responsibilities for eye and face protection in his/her laboratory.
3) Analyze the student's responsibilities in assuring adequate eye and face protection in the laboratory.

SPECIAL TERMS

Hazard recognition
Hazard evaluation
Hazard control
Job analysis
Key quality or production factor
Key safety factor
Task analysis

INSTRUCTOR MATERIALS

Lesson Plan
State Health/Safety Laws and Regulations (if available)
Chalkboard, Chalk, Eraser

TRAINEE MATERIALS

Lesson Plan (complete)

CONTENTS

INTRODUCTION W-5-3

Directions W-5-3

EXERCISE 1 . . . . W-5-4

EXERCISE 2 . . . . W-5-5

EXERCISE 3 . . . . W-5-6

EXHIBITS

W-5-1. Regulations for Eye and Face Protection under the OSH Act W-5-7

W-5-2. Recommended Eye and Face Protectors for use in Industry, Schools, and Colleges W-5-9

W-5-3. Job Analysis W-5-11

WORKSHEETS

W-5-1. Hazard Analysis W-5-15

W-5-2. Teacher Responsibilities for Eye and Face Protection W-5-17

W-5-3. Student Job Analysis W-5-19

LESSON Workshop on Eye and Face Protection **NO.** W-5

NOTES	INSTRUCTION
	INTRODUCTION This workshop is planned around 3 desk-type exercises that give laboratory teachers a chance to practice real-world skills used in the field of occupational safety and health. Each exercise consists of a worksheet to complete and an exhibit to use as background or reference material. The worksheets are designed for group or individual completion and review. They may be completed before or during the actual workshop session, depending on the training schedule.
Recommendations	Directions
See Lesson 5.	1. Schedule the workshop at least one day after the lecture on eye and face protection.
Duplicate trainee materials in advance.	2. Distribute trainee materials at least a day before the workshop, asking that worksheets be completed individually before the session.
Allow about 15 minutes.	3. Divide trainees into 3 small groups for the workshop session. Each group should focus on the review of only one exercise.
Allow about 10 minutes for each exercise.	4. Ask an individual or panel for each group to lead the general discussion of results for each exercise.
Allow about 5 minutes. See Overview, p. W-5-1.	5. Summarize the entire session in terms of the workshop purpose and objectives.

LESSON Workshop on Eye and Face Protection NO. W-5

NOTES	INSTRUCTION
	EXERCISE 1
	This is a preliminary "desk survey" of the work area, designed to take stock of potential hazards and what is being done about them.
Worksheet W-5-1	Worksheet
	The worksheet is a questionnaire that can be used for almost any area of concern. In this case, of course, it is eye and face protection.
	Items to be completed cover the 3 basic approaches to the study of hazards: (1) Recognition or identification (2) Evaluation or measurement (3) Control or prevention
	The choices given are commonly found in industrial situations. Some of these topics are treated in other lessons in this course.
Exhibit W-5-1	Exhibit
29 CFR 1910	An excerpt from Federal regulations on eye and face protection for workers is included as background material.
	Similar state regulations for workers or school personnel may be substituted or added.

LESSON Workshop on Eye and Face Protection NO. W-5

NOTES	INSTRUCTION
	EXERCISE 2
	This is a planning exercise to determine the responsibilities of the teacher for eye and face protection in the science laboratory.
Worksheet W-5-2	Worksheet
	Need is first established by providing guidelines for documenting the dimensions of problems and solutions.
	Teacher responsibilities are then elicited as tasks to be performed in specific phases of protective equipment management.
Exhibit W-5-2	Exhibit
ANSI Z87.1-1968	A selection chart from the American National Standard Practice for Occupational and Educational Eye and Face Protection is presented for reference. The entire standard should be included in the library of every school and science department.

LESSON Workshop on Eye and Face Protection NO. W-5

NOTES	INSTRUCTION
	EXERCISE 3
	This analytical exercise may serve many purposes in curriculum planning. Its primary role in this workshop is to help the teacher delineate student responsibilities for eye and face protection in the science laboratory.
Worksheet W-5-3	Worksheet
	The focal point of the exercise is the examination of student laboratory work as a job analysis. The form to be completed is adapted from one used in industrial situations.
Exhibit W-5-3	Exhibit
	Background information is provided by text and a sample job analysis from industry. A sample application of this technique to the school science laboratory is also included. The term "key quality or production factors" may be interpreted as "learning experiences" or "performance objectives" or "laboratory procedures" in a school setting. The same goes for "key safety factors". The latter may also be called "safety principles".

EXHIBIT W-5-1. REGULATIONS FOR EYE AND FACE PROTECTION UNDER THE OSH ACT

SUBPART I - PERSONAL PROTECTIVE EQUIPMENT

Section 1910.132 - General Requirements

(a) Application.

Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

(b) Employee-owned equipment.

Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

(c) Design.

All personal protective equipment shall be of safe design and construction for the work to be performed.

Section 1910.133 - Eye and Face Protection

(a) General.

(1) Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

(2) Protectors shall meet the following minimum requirements:

(i) They shall provide adequate protection against the particular hazards for which they are designed.

(ii) They shall be reasonably comfortable when worn under the designated conditions.

(iii) They shall fit snugly and shall not unduly interfere with the movements of the wearer.

(continued on next page)

Exhibit W-5-1 (page 2 of 2)

(iv) They shall be durable.

(v) They shall be capable of being disinfected.

(vi) They shall be easily cleanable.

(vii) Protectors should be kept clean and in good repair.

(3) Persons whose vision requires the use of corrective lenses in spectacles, and who are required by this standard to wear eye protection, shall wear goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction.

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.

(5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.

(6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1-1968.

Source: "Code of Federal Regulations, Title 29, Part 1910 - Occupational Safety and Health Standards," Federal Register, 39:23670-23671 (June 27, 1974).

PAGE W-5-9 REMOVED PRIOR TO BEING
SHIPPED TO EDRS FOR FILMING DUE TO
COPYRIGHT RESTRICTIONS

PAGES W-5-11 THROUGH W-5-13 REMOVED PRIOR TO
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Exhibit W-5-3 (page 4 of 4) STUDENT JOB ANALYSIS (SAMPLE)

Basic Steps	Laboratory Procedures	Safety Principles
1. Attend all class sessions, if possible.	1. Arrive on time. Inform teacher of any health problems. Assume the responsibility for make-up work.	1. Important information may be missed by tardiness or absence But don't risk health or expose others because of illness.
2. Bring only proper clothing and materials to class.	2. Follow lab rules with no exceptions or excuses. Keep special clothing in locker, if necessary.	2. Improper clothing and materials may cause accidents
3. Wash-up, as necessary	3. Maintain good personal hygiene.	3. Lack of cleanliness may cause or complicate infections or injuries.
4. Prepare work area.	4. Clear work area of all unnecessary materials. Read and follow directions for lab work. Ask the teacher when in doubt.	4. Clutter may cause accidents. Lab procedures for students have been "debugged" for potential hazards.
5. Clean-up work area and materials.	5. Clean reusable materials as directed. Clean and arrange work area as found.	5. Breakage, damaged equipment, spills, and trash may cause fires or personal injury.
6. Store or dispose of materials.	6. Read and follow all directions. Ask the teacher when in doubt.	6. Proper storage not only helps preserve materials in good condition, but also helps prevent fires and explosions.
7. Complete homework.	7. Come to class prepared.	7. Knowledge is one of the best means of accident prevention.

EXHIBIT W-5-3. JOB ANALYSIS

Job analysis is a tool that enables the supervisor to teach and direct his employees systematically in order to obtain optimum job efficiency. Since efficiency demands maximum use and control of the men, equipment, machines and environment involved in any job, the potential sources of traumatic injury and environmental health exposures are evaluated along with all other factors associated with production and quality control. Once completed, a good job analysis provides the blueprint to teach any worker how to do a critical job the safe, productive way. The actual preparation of a job analysis provides another enormous opportunity to detect actual or potential sources of occupational injury or health problems at the pre-contact stage of accident control.

Methodology. Jobs that are determined to be serious risks to safety, quality or production become the "critical few" first targets for analysis. Selection may be based on the frequency or severity of past loss history or the potential for loss. The regular maintenance and updating of the analysis is an important aspect of any job analysis program. A job analysis is best prepared by actual observations of a worker or workers doing the job. When infrequently performed jobs prevent the observation method of conducting a job analysis, the technique of group discussion can be employed as an alternative.

The four basis steps in conducting a job analysis are: (a) determining the job to be analyzed, (b) breaking the job down into a sequence of steps, (c) determining key factors related to each job step, and (d) performing an "efficiency check". The final step involves determining that each step of the job is done in the best and most efficient way. This final step frequently involves a job procedure or methods change, a job environment change or a technique to reduce the number of times the job must be done. The savings alone that result from the accomplishment of this step have consistently proved to be justification for introduction of the program.

There are two basic approaches in doing a job analysis. One that has been used extensively in the past is the "Job Safety Analysis" technique that produces an end product dealing purely with safety. While there are unquestionable merits for treating this important subject in this manner, the author personally favors the complete approach referred to as "Proper Job Analysis," "Total Job Analysis" or just plain "Job Analysis," as the individual plant designates. This latter approach seems to have more appeal to management people at all levels, since it is based on the new concept of safety as one of the many inseparable parts of the supervisor's job. Figure 47-1 is an example of this approach.

Benefits. While there are many benefits that come with a Job Analysis program, none is more important than the peace of mind that a concerned management group has in knowing that it has provided a tool to insure that the actual potential sources of traumatic injury and environmental health exposures have been carefully analyzed and evaluated for all critical jobs.

Exhibit W-5-3 (page 2 of 4)

Where complete elimination of hazards detected is not economically feasible or practical at the time a job analysis is accomplished, the completed job analysis provides the guidelines to accomplish the job safely by following the clearly defined method of procedure.

Source: Bird, F.E., Jr., "Safety," The Industrial Environment - Its Evaluation & Control. NIOSH. U.S. Government Printing Office, Washington, D. C. (1973). Chapter 47, pp. 681-691. Excerpted text and figure on pp. 684-686.

WORKSHEET W-5-1. HAZARD ANALYSIS

Complete this page and the next page for your school or work area.

NAME ______________________________ DATE ____________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY __________________________ STATE ____________

1. Area of Concern (Example: Eye and Face Protection)

____

2. What potential safety and health hazards exist?	Yes	No	?
a. Biological	____	____	____
b. Chemical	____	____	____
c. Electrical	____	____	____
d. Mechanical	____	____	____
e. Psychological	____	____	____
f. Radiological	____	____	____
g. Other (specify) ____________________	____	____	____
h. Most important of the above ____ (letter)			

3. What means are available to measure and evaluate the above hazards and/or their effects?	Yes	No	?
a. Conference or Consultation with Experts	____	____	____
b. Laboratory Analysis	____	____	____
c. Medical Records (Staff and Student)	____	____	____
d. Other Records and Reports	____	____	____
e. Research	____	____	____
f. Sampling	____	____	____
g. Site Surveys	____	____	____
h. Other (specify) ____________________	____	____	____
i. Most important of the above ____ (letter)			

Worksheet W-5-1 (page 2 of 2) Name ______________________

4. What means are now used to control the hazards and prevent accidents, injuries, and illnesses?

	Yes	No	?
a. Administrative Directives	____	____	____
b. Barriers, Guards, Shields	____	____	____
c. Education, Training	____	____	____
d. Housekeeping	____	____	____
e. Labels, Signs	____	____	____
f. Medical, First Aid	____	____	____
g. Personal Protective Equipment	____	____	____
h. Ventilation	____	____	____
i. Work Practices	____	____	____
j. Other (specify) ______________________	____	____	____

k. Most important of the above ____ (letter)

5. Name or describe specific means of hazard control for which the "yes" column is checked in item 4 above.

Example: a. Eye Protection Policy

WORKSHEET W-5-2. TEACHER RESPONSIBILITIES FOR EYE AND FACE PROTECTION

Complete this page and the next page for your school or work area.

NAME DATE

TITLE

SCHOOL

DEPARTMENT

LOCATION: CITY STATE

1. Courses for which eye and face protection is needed.

	Title	No. Students
a.		
b.		
c.		
d.		
e.		
f.		
g.		

2. Special problems in the above.

3. Protection required.

	Type	Description	No.
a.	Safety Glasses		
b.	Safety Goggles		
c.	Face Shields		
d.	Eyewash Fountains		
e.	Eyewash Stations		
f.	First Aid Kits		
g.	Other (specify)		

Worksheet W-5-2 (page 2 of 2) Name ____________________

---

4. Likelihood of the following: Percentage

   a. Teachers will furnish own personal protective equipment. ______

   b. Students will furnish own personal protective equipment. ______

   c. Schools will furnish equipment for laboratory visitors. ______

5. Write below at least one task the laboratory teacher should perform for each aspect of protective equipment management.

   a. Planning

   b. Selection

   c. Distribution

   d. Fitting

   e. Usage

   f. Storage

   g. Maintenance

   h. Repair

   i. Evaluation

   j. Other

WORKSHEET W-5-3. STUDENT JOB ANALYSIS

Complete this page and the next 3 pages for your school or work area.

NAME DATE

TITLE

SCHOOL

DEPARTMENT

LOCATION: CITY STATE

1. Area of Concern (Example: Eye and Face Protection)

2. Course (Example: Introduction to Chemistry) Grade Level

3. Prerequisites (Example: General Science)

4. Safety-oriented tasks each student should perform in laboratory work for the course named above.
   a. Review the text and samples in Exhibit W-5-3.
   b. Prepare a similar table of tasks for students, using the job analysis form on the next page.
   c. Comment below, if desired.

Worksheet W-5-3 (page 2 of 4) STUDENT JOB ANALYSIS Name ____________________

Basic Steps	Laboratory Procedures	Safety Principles

Name ____________________

5. What do students need to know in order to perform the tasks previously described?

This is only a preliminary analysis of education/training requirements. The results will serve as input for later steps in preparing subject matter structures and performance objectives.

Worksheet W-5-3 (page 4 of 4) Name ____________________

---

6. How should students be evaluated on their ability to perform the lab tasks previously analyzed?

7. What do you recommend for students who are unwilling or unable to perform the required lab tasks in the prescribed manner?

SAFETY IN THE SCHOOL SCIENCE LABORATORY (250)

WORKSHOP ON LABELING CHEMICALS

NO. W-8

METHODS Practical Exercises and Discussion **LENGTH** 50 minutes

PURPOSE

Provide opportunities to apply labeling knowledge and skills to laboratory situations.

OBJECTIVES

Enable the trainee to ...

1) Conduct an inventory of laboratory materials.
2) Set up a system for recording reference information and making labels.
3) Determine teacher and student responsibilities in labeling activities.

SPECIAL TERMS

- Fire/flammability signal
- Health hazard signal
- Label data file
- Label statement
- Material Safety Data Sheet (MSDS)
- Reactivity signal

INSTRUCTOR MATERIALS

- Lesson Plan
- Appendices B and C
- Chalkboard and Eraser
- Chalk (white, blue, red, yellow)
- MCA and NFPA References (if possible)

TRAINEE MATERIALS

- Lesson Plan (complete)
- Appendices B and C (if possible)

CONTENTS

INTRODUCTION W-8-3

Directions W-8-3

EXERCISE 1 . . . . W-8-4

EXERCISE 2 . . . . W-8-5

EXERCISE 3 . . . . W-8-6

EXHIBITS

W-8-1. Sample Inspection Sheet for Controlled Chemicals. . . W-8-7

W-8-2. NFPA Recommendations for Labeling Chemicals W-8-9

W-8-3. Material Safety Data Sheet W-8-11

W-8-4. Hazard Ratings and Signal Words W-8-15

W-8-5. Selection of Label Statements W-8-17

W-8-5a. Health Related Statements W-8-18

W-8-5b. Health Hazard Action Statements W-8-19

W-8-5c. Fire Amplifying Statements W-8-20

W-8-5d. Fire Hazard Action Satements W-8-21

W-8-5e. Reactivity Amplifying Statements W-8-22

W-8-5f. Reactivity Hazard Action Statements W-8-23

W-8-5g. First Aid Statements W-8-25

W-8-5h. Statements Specifying Specific Disposal Instructions. W-8-26

W-8-5i. Sample Label W-8-27

WORKSHEETS

W-8-1. Materials Inventory W-8-29

W-8-2. Label System W-8-33

W-8-3. Teacher and Student Responsibilities for Labeling . . W-8-39

LESSON Workshop on Labeling Chemicals **NO.** W-8

NOTES	INSTRUCTION

INTRODUCTION

Labeling and related activities should be one of the most "natural" aspects of a safety program for the U.S. school science laboratory. Much attention has been given to labels for home products in the past 20 years. The Federal Hazardous Substances Labeling Act for household chemicals was passed in 1960.

We now take for granted the protective information on household labels, but tend to forget that chemicals in the science lab are at least as dangerous and usually more so.

We know what to do when a child swallows a home cleaner because it says so on the label. But do we know what to do when a youngster swallows a solvent in class? Indeed, do we know everything we should about that chemical? An adequate label is a means of conveying warnings and other information about appropriate handling to all who will read it.

Directions

Follow the general procedures for workshops or directions provided by the instructor.

LESSON Workshop on Labeling Chemicals NO. W-8

NOTES	INSTRUCTION
	EXERCISE 1 All of the workshops in this training course begin with an inventory or identification of material hazards in the school labs in which teachers are actually working.
Worksheet W-8-1	Worksheet The first exercise in this workshop begins with a description of what is presently done about inventories of lab materials. Additional items provide opportunities to suggest what might be done if current information and procedures are inadequate.
Exhibit W-8-1	Exhibit Your school system or the local fire department may use standard inventory and inspection forms.

LESSON Workshop on Labeling Chemicals NO. W-8

NOTES	INSTRUCTION
	EXERCISE 2
	This is a "do-it-yourself" project in collecting data and preparing labels for laboratory materials.
Worksheet W-8-2	Worksheet
	Experience is simulated by providing possible label information from which to choose, based on recommendations from several sources.
Exhibits W-8-2 to 5i	Exhibits
	Exhibit W-8-2 gives the recommendations of NFPA for label signals.
	Exhibits W-8-3 through W-8-5i are taken from the following NIOSH publications:
NIOSH Reference	Criteria for a Recommended Standard: An Identification System for Occupationally Hazardous Materials. HEW Publication No. (NIOSH) 75-126. U.S. Government Printing Office, Washington, D. C. (1974).

LESSON Workshop on Labeling Chemicals NO. W-8

NOTES	INSTRUCTION
	EXERCISE 3 Results from both previous exercises will probably generate many new ideas about what teachers and students should be doing with regard to labeling lab materials. This exercise is designed to get those ideas on paper for discussion and further consideration in the course and in the future.
Worksheet W-8-3	Worksheet Exercises 1 and 2 give you a chance to get organized, documenting general needs and perhaps important constraints. Exercise 3 should result in a plan for A. Inventory B. Label Data File (reference info) C. Label Preparation D. Other Labeling Activities
Exhibits W-8-1 to 5i	Exhibits Use any or all in this lesson plan.

PAGE W-8-7 REMOVED PRIOR TO BEING
SHIPPED TO EDRS DUE TO COPYRIGHT
RESTRICTIONS.

PAGES W-8-9 and W-8-10 REMOVED PRIOR
TO BEING SHIPPED TO EDRS FOR FILMING
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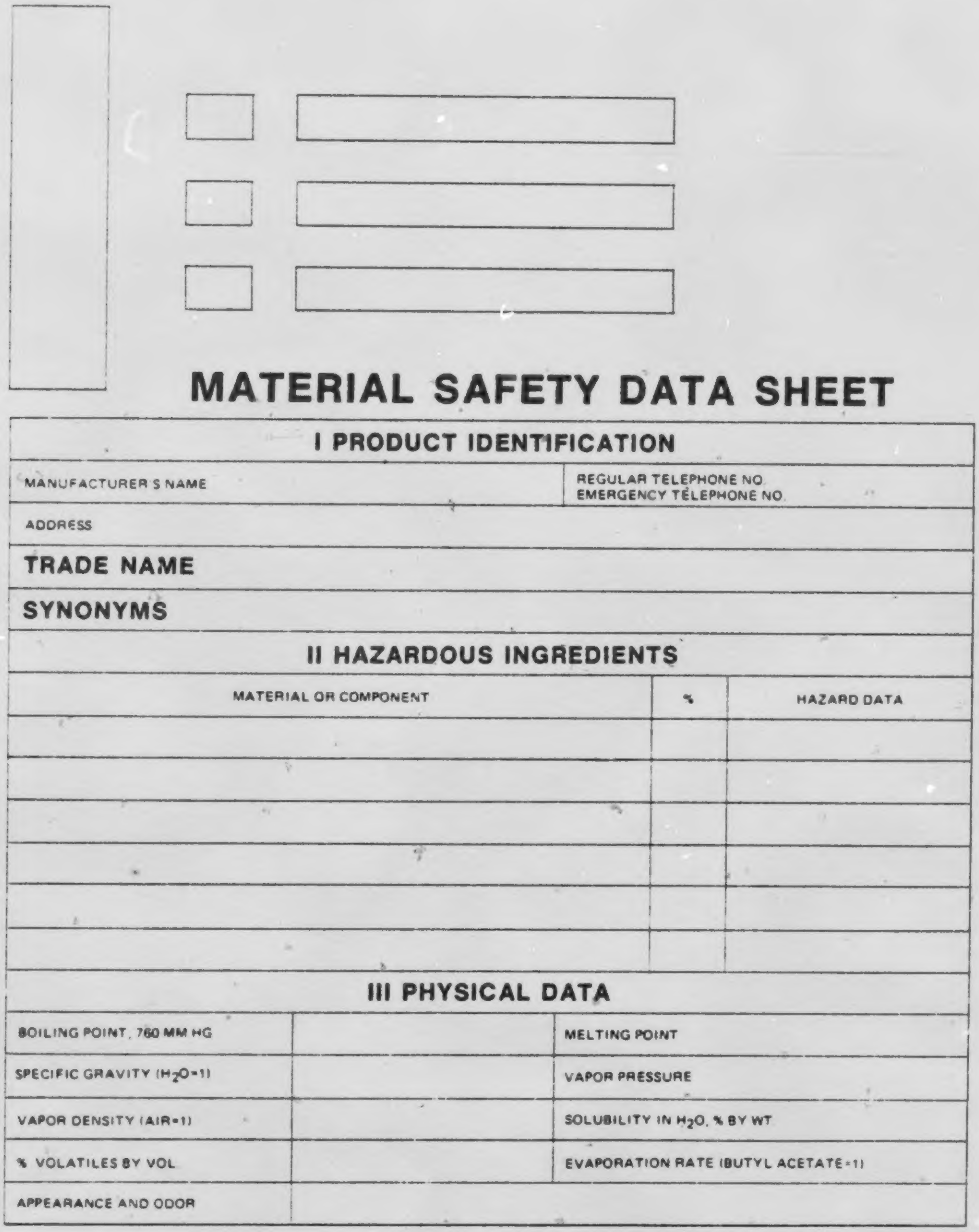
EXHIBIT W-8-3. MATERIAL SAFETY DATA SHEET

(75% Reduction)



MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME	REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.
ADDRESS	
TRADE NAME	
SYNONYMS	

II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	%	HAZARD DATA

III PHYSICAL DATA

BOILING POINT, 760 MM HG		MELTING POINT	
SPECIFIC GRAVITY (H_2O=1)		VAPOR PRESSURE	
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H_2O, % BY WT	
% VOLATILES BY VOL		EVAPORATION RATE (BUTYL ACETATE=1)	
APPEARANCE AND ODOR			

Exhibit W-8-3 (page 2 of 4)

IV FIRE AND EXPLOSION DATA

FLASH POINT (TEST METHOD)			AUTOIGNITION TEMPERATURE		
FLAMMABLE LIMITS IN AIR, % BY VOL.	LOWER		UPPER		
EXTINGUISHING MEDIA					
SPECIAL FIRE FIGHTING PROCEDURES					
UNUSUAL FIRE AND EXPLOSION HAZARD					

V HEALTH HAZARD INFORMATION

HEALTH HAZARD DATA

ROUTES OF EXPOSURE

- INHALATION
- SKIN CONTACT
- SKIN ABSORPTION
- EYE CONTACT
- INGESTION

EFFECTS OF OVEREXPOSURE

- ACUTE OVEREXPOSURE
- CHRONIC OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

- EYES
- SKIN
- INHALATION
- INGESTION

NOTES TO PHYSICIAN

Exhibit W-8-3 (page 3 of 4)

VI REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

INCOMPATIBILITY

HAZARDOUS DECOMPOSITION PRODUCTS

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

NEUTRALIZING CHEMICALS

WASTE DISPOSAL METHOD

VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY (SPECIFY IN DETAIL)

EYE

GLOVES

OTHER CLOTHING AND EQUIPMENT

Exhibit W-8-3 (page 4 of 4)

IX SPECIAL PRECAUTIONS

PRECAUTIONARY STATEMENTS

OTHER HANDLING AND STORAGE REQUIREMENTS

PREPARED BY:

ADDRESS:

DATE:

EXHIBIT W-8-4. HAZARD RATINGS AND SIGNAL WORDS

Rating	Health Hazards	Flammability	Reactivity
4	EXTREME HEALTH HAZARD	EXTREMELY FLAMMABLE	EXTREMELY REACTIVE
3	HIGH HEALTH HAZARD	HIGHLY FLAMMABLE	HIGHLY REACTIVE
2	MODERATE HEALTH HAZARD	MODERATELY COMBUSTIBLE	MODERATELY REACTIVE
1	SLIGHT HEALTH HAZARD	SLIGHTLY COMBUSTIBLE	SLIGHTLY REACTIVE
0	NO SIGNIFICANT HEALTH HAZARD	NONCOMBUSTIBLE	NONREACTIVE

EXHIBIT W-8-5. SELECTION OF LABEL STATEMENTS

Label statements are intermediate in information content between the hazard symbol and the detailed Material Safety Data Sheets. It is stressed that the requirements detailed in this section are minimal because of the complexity and diversity of hazardous materials. Additional warnings and detailed medical and other information may be desirable on labels attached to containers of new or unusual materials. In addition, the manufacturer or user may supply additional cautions on ecological or other matters, as appropriate.

Suggested label statements are supplied for guidance only. Label wording should be tailored specifically for each material or combination of materials.

For health hazards, the major considerations are modes of entry, speed of attack, and whether the effects are acute or chronic.

For fire hazards, considerations include vapor pressure and vapor density, autoignition temperature, explosive limits, viscosity, products of combustion, and extinguishing media.

Reactivity hazards require knowledge of sensitivity to detonation by shock or heat, tendency to rapid polymerization, reactivity with common substances, ability to supply oxygen in a fire situation, and other special harmful properties.

The number of statements used will depend on the hazard involved. Extremely dangerous materials may require extensive warnings and detailed instructions for safe use and disposal. Minimally hazardous substances may require little more than the hazard statement. Specific and more detailed first aid statements including notes to physicians may be necessary for extremely hazardous materials. These statements are best formulated by physicians familiar with the hazards of the specific material and aware of the capabilities of industrial paramedical personnel and facilities.

EXHIBIT W-8-5a. HEALTH RELATED STATEMENTS

1. Fatal if swallowed
2. Fatal if inhaled
3. Fatal if absorbed through the skin
4. Harmful if swallowed
5. Harmful if inhaled
6. Harmful if absorbed through the skin
7. Can cause allergic respiratory reaction
8. Can cause allergic skin reaction
9. Vapor (gas) may cause suffocation
10. Causes eye burns
11. Causes eye irritation
12. Causes burns
13. Causes irritation
14. Can be fatal or cause blindness if swallowed
15. Cannot be made nonpoisonous
16. Repeated absorption can cause bladder tumors
17. Rapidly absorbed through skin
18. Inhalation can be fatal or cause delayed lung damage
19. Harmful if inhaled and can cause delayed lung damage
20. Can cause delayed effect
21. Vapor extremely irritating
22. Extremely irritating gas and liquid under pressure
23. Gas extremely irritating
24. Lung injury and burns may be delayed
25. Contact with water or moist air liberates irritating gas
26. Contact with acid liberates poisonous gas
27. Contact with water or acid slowly liberates poisonous and flammable hydrogen sulfide gas
28. Liberates gas which may cause suffocation
29. Repeated inhalation or skin contact can, without symptoms, increase hazard
30. Causes severe burns which may not be immediately painful or visible
31. Can cause rash or external sores
32. Can cause burns or external sores
33. Liquid or vapor causes burns which may be delayed
34. May cause eye injury-effects may be delayed
35. Liquid penetrates shoes and leather causing delayed burns
36. May cause sterility
37. May affect unborn children
38. Cancer suspect agent

EXHIBIT W-8-5b. HEALTH HAZARD ACTION STATEMENTS

---

1. Do not breathe dust
2. Do not breathe vapor
3. Do not breathe mist
4. Do not breathe gas
5. Do not get in eyes, on skin, on clothing
6. Prevent contact with food, chewing or smoking materials
7. Wash thoroughly after handling
8. Use only in well ventilated area
9. Keep container closed
10. Avoid prolonged or repeated contact with skin
11. Do not enter storage areas unless well ventilated
12. Avoid breathing dust or solution spray or vapor
13. Avoid prolonged or repeated breathing of vapor
14. Use special protective clothing and gloves
15. Wear goggles; neoprene, butyl rubber, or vinyl gloves; neoprene shoes or boots; and clean protective outer clothing
16. Wear goggles, neoprene, butyl rubber, or vinyl gloves
17. Always wear a self-contained breathing apparatus or full-face air-line respirator when using this product
18. Have available emergency self-contained breathing apparatus or full-face air-line respirator when using this product
19. Wear respirator approved by NIOSH or the US Bureau of Mines for organic vapor, dust, etc.
20. Wear goggles or face shield, rubber gloves, and protective clothing when handling
21. Do not wear ordinary rubber protective clothing, including gloves and boots
22. Do not taste
23. This gas deadens the sense of smell. Do not depend on odor to detect presence of gas
24. Use fresh clothing daily. Take hot shower at end of work shift using plenty of soap
25. POISON (with skull and crossbones symbol)
26. Avoid exposing women of child-bearing age

EXHIBIT W-8-5c. FIRE AMPLIFYING STATEMENTS

1. Strong Oxidizer - contact with other materials may cause fire
2. Catches fire if exposed to air
3. Spillage may cause fire or liberate dangerous gas
4. Highly volatile
5. Contact with water or acid slowly liberates flammable gas
6. Contact with water may cause flash fire
7. May ignite if allowed to become damp
8. Heat, shock, or contact with other materials may cause fire or explosive decomposition
9. Contact with other materials may cause fire or explosion, especially if heated

EXHIBIT W-8-5d. FIRE HAZARD ACTION STATEMENTS

---

1. Keep away from fire, sparks and open flame
2. Keep from contact with clothing and other combustible materials to avoid fire
3. Drying of this product on clothing or combustible materials may cause fire
4. Spills on clothing or combustible materials may cause fire
5. Contents packed under water will ignite if water is removed
6. Avoid friction or rough handling because of fire hazard
7. Keep wet in storage--dry powder may ignite by friction, static electricity or heat
8. Wear goggles or face shield and fire-retardant clothing when handling
9. Clothing and vegetation contaminated with chlorate or its solutions are DANGEROUSLY FLAMMABLE. Remove clothing and wash thoroughly in water. Keep persons and animals off treated areas
10. Store in cool place
11. Keep container tightly closed
12. Loosen closure cautiously before opening
13. Store in cool dry place
14. Store in a cool place in original container and protect from direct sunlight
15. In case of fire, stop flow of gas. Use dry chemical or carbon dioxide when necessary to gain access to valve
16. Avoid spillage and contact with moisture or combustion
17. In case of spillage, flush with plenty of water and remove contaminated articles
18. Flush area with water spray
19. In case of fire, smother with dry sand, dry ground limestone or dry powder type materials specially designed for metal powder fires.
20. Spillage may cause fire. Do not get on floor. Sweep up and remove immediately

EXHIBIT W-8-5e. REACTIVITY AMPLIFYING STATEMENTS

---

1. Powerful Oxidizer
2. Strong Oxidizer
3. Strong Acid
4. Strong Caustic (alkali)
5. Causes severe burns which may not be immediately painful or visible
6. Heat, shock, or contact with other materials may cause fire or explosion, especially if heated
7. Contact with other material may cause fire or explosion, especially if heated
8. Reacts violently with water, liberating and igniting hydrogen
9. May form explosive peroxides
10. Forms shock-sensitive mixtures with certain other materials
11. May explode if water content is 10% or below
12. Contamination may result in dangerous pressure
13. Liquid and gas under pressure
14. Extremely hazardous liquid and vapor under pressure
15. Extremely cold (give degrees F or C below zero)
16. High Explosive
17. Explosive
18. Inhibited monomer, subject to violent polymerization
19. Liquid and gas under pressure
20. Gas under pressure

EXHIBIT W-8-5f. REACTIVITY HAZARD ACTION STATEMENTS

1. Keep from contact with oxidizing materials, highly oxygenated or halogenated solvents, organic compounds containing reducible function groups, or aqueous ammonia
2. Keep from contact with oxidizing materials
3. Keep from contamination from any source including metals, dust, and organic materials. Such contamination can cause rapid decomposition, generation of high pressures, or formation of explosive mixtures
4. Solidifies at about F (C) and may break container. Store in moderately warm place
5. Keep from any contact with water
6. Use only dry, clean utensils in handling
7. While making solutions, add slowly to surface to avoid violent splattering
8. Keep wet in storage--dry powder may ignite by friction, static electricity, or heat
9. Do not add to hot materials; do not grind or subject to frictional heat or shock--explosive decomposition may result
10. Prevent contamination with readily oxidizable materials and polymerization accelerators
11. Do not allow to evaporate to near dryness. Addition of water or appropriate reducing materials will lessen peroxide formation
12. Do not add water to contents while in a container because of violent reaction and possible flash fire
13. Do not attempt to loosen or remove material from container with any tool
14. Wear goggles and DRY gloves when handling
15. Put nothing else in this container
16. Keep dry and handle only in suitable equipment to prevent metallic contamination. Consult manufacturer
17. Keep container tightly closed and away from water or acids
18. Keep container tightly closed; flush container clean before discarding
19. Do not put in stoppered or closed container
20. Note: Suck-back into cylinder may cause explosion. Under no circumstances should the cylinder entry tube be inserted in a liquid or gas without a vacuum break or other protective apparatus in the line to prevent suck-back
21. Store in original vented container
22. Store in cool place
23. Keep drum in upright position. Do not roll drum on side
24. Handle under inert gas atmosphere in DRY equipment
25. Keep from freezing
26. Loosen closure cautiously before opening
27. Store separately from, and avoid contact with, dehydrating materials and other materials
28. Keep away from fire
29. Open container carefully and only in dry oxygen-free or inert atmosphere
30. Store in cool dry place
31. Store in cool place in original container and protect from direct sunlight

Exhibit W-8-5f (page 2 of 2)

32. Keep container closed to prevent drying out
33. Do not heat cylinders
34. Keep away from acids and heat
35. Never return unused HYDROGEN PEROXIDE to container. Dilute with plenty of water
36. Avoid spillage and contact with moisture or combustibles
37. Fire or high temperatures may cause explosive decomposition if confined
38. In case of fire, smother with dry sand, dry ground limestone, or dry powder type materials specially designed for metal powder fires. Do not use carbon tetrachloride, carbon dioxide extinguishers, or water
39. Do not use air pressure to transfer

EXHIBIT W-8-5g. FIRST AID STATEMENTS

---

1. First Aid CALL A PHYSICIAN AS SOON AS POSSIBLE
   If swallowed, induce vomiting by sticking finger down throat or by giving soapy or strong salty water to drink. Repeat until vomit is clear. Never give anything by mouth to an unconscious person.

2. First Aid CALL A PHYSICIAN AS SOON AS POSSIBLE
   In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. (Discard contaminated shoes.)

3. First Aid CALL A PHYSICIAN AS SOON AS POSSIBLE
   If inhaled, remove to fresh air. If not breathing give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen.

4. First Aid CALL A PHYSICIAN AS SOON AS POSSIBLE
   In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses if worn.

5. First Aid CALL A PHYSICIAN AS SOON AS POSSIBLE
   In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Flush skin with water. (Wash clothing before reuse.)

6. First Aid
   In case of contact, immediately wash skin with soap and plenty of water.

7. First Aid
   Do NOT induce vomiting. Call a physician as soon as possible.

8. Antidote: (indicate commonly available antidote.)

9. Note to Physicians: (Give detailed specific treatment including drug dosage.)

10. Call the Life Squad or local emergency unit.

EXHIBIT W-8-5h. STATEMENTS SPECIFYING SPECIFIC DISPOSAL INSTRUCTIONS

1. Flush spill area with water spray.
2. Soak up spill with sand or earth. Do not use water.
3. Flush away spill by flooding with water applied quickly to entire spill.
4. Keep upwind of leak: Evacuate enclosed places until gas has dispersed.
5. Dike spill and decontaminate by...
6. Do not flush into sewers.
7. Dispose of sodium by burning carefully in an open fire.
8. Sweep up spillage with strong calcium hypochlorite solution.
9. Treat spillage with strong calcium hypochlorite solution and flush to sewer.
10. In case of spillage, keep wet and remove carefully.
11. Soak up with rags and dispose in covered metal containers.
12. Consult local solid waste regulations for safe disposal.
13. Do not sweep. Use vacuum cleaning equipment only.

EXHIBIT W-8-5i. SAMPLE LABEL

4	Extreme Health Hazard
4	Extremely Flammable
2	Moderately Reactive

Fatal if swallowed, inhaled, or absorbed through the skin.

Causes severe eye burns.

Protect from all sources of ignition.

Subject to violent polymerization.

Do not breathe vapor or get in eyes, on skin, on clothing.

When possibility of contact exists:
    Wear full neoprene suit, rubber boots, rubber gloves,
    and self-contained breathing apparatus.

Avoid contact with acid, organic compounds, or water.

FIRST AID CALL A PHYSICIAN AS SOON AS POSSIBLE

Immediately upon exposure, flush skin and eyes with water for 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Discard contaminated shoes.

Refer to Data Sheet on file.

WORKSHEET W-8-1. MATERIALS INVENTORY

Complete this page and the next 3 pages for your school or work area.

NAME ________________________________ DATE __________

TITLE ________________________________

SCHOOL ________________________________

DEPARTMENT ________________________________

LOCATION: CITY ____________________________ STATE __________

1. Describe your present inventory system.

   a. What materials do you inventory? ____________________

   b. How often do you inventory? ____________________

   c. Who takes the inventory? ____________________

   d. What kind of form do you use? ____________________

   e. What data do you record? ____________________

      (1) ________________________________

      (2) ________________________________

      (3) ________________________________

      (4) ________________________________

      (5) ________________________________

2. What do you do with the inventory data?

   Example: File it in a folder.

Worksheet W-8-1 (page 2 of 4) Name ____________

3. If you were asked to design a new inventory form, what kind of data would you elicit? List below in order of importance and explain why.

   a. Name of Material

   b. Amount

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

4. What disposition would you recommend for your new inventory form?

5. Apply your answers above to pages 3 and 4 of this worksheet.

   a. Use the top part of page 3 to design a page header.

   b. Add appropriate column headers and draw vertical lines accordingly.

   c. Take or simulate an inventory of at least 10 typical materials found in your laboratory or stockroom.

Worksheet W-8-1 (page 3 of 4) Name ______________________

Worksheet W-8-1 (page 4 of 4) Name ____________

W-8-32

WORKSHEET W-8-2. LABEL SYSTEM

Complete the following pages for your school or work area.

NAME ______________________________ DATE __________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY __________________________ STATE __________

---

1. The information below is given in reference charts prepared by the Manufacturing Chemists' Association for the Guide to Safety in the Chemical Laboratory (1972, pp. 323-498).

		(A)	(B)
a.	Substance/Formula	____	____
b.	Waste Disposal Procedure (Code)	____	____
c.	TLV (ACGIH) PPM (mg/M^3)	____	____
d.	NFPA Hazard Signals	____	____
e.	Specific Gravity	____	____
f.	Vapor Density	____	____
g.	Flash Point	____	____
h.	Ignition Temperature	____	____
i.	Flammable or Explosive Limits in Air	____	____
j.	Boiling Point	____	____
k.	Melting Point	____	____
l.	Solubility in H_2O g/100g	____	____

In column (A) to the right, check the information you would record for reference in your own laboratory.

In column (B) to the right, check the information you would put on labels for substances in your laboratory.

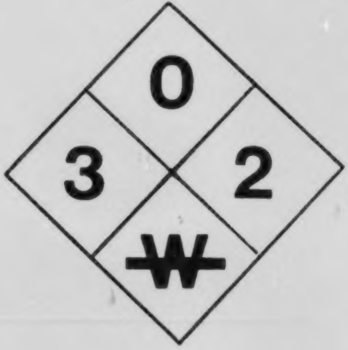
Worksheet W-8-2 (page 2 of 6)   Name ____________________

2. What additional information is desirable? List below in order of importance.

		Reference (A)	Label (B)
a.	________________________________	_____	_____
b.	________________________________	_____	_____
c.	________________________________	_____	_____
d.	________________________________	_____	_____
e.	________________________________	_____	_____
f.	________________________________	_____	_____
g.	________________________________	_____	_____
h.	________________________________	_____	_____
i.	________________________________	_____	_____
j.	________________________________	_____	_____

3. Page 3 of this Worksheet shows a sample form for recording information in a reference manual for your laboratory.

   Complete this form for sulphuric acid.



4. Page 4 of this Worksheet uses a labeling system proposed by NIOSH.

   Complete the blanks for sulphuric acid.

5. Page 5 of this Worksheet provides opportunities to design labels for two given situations and a third of your choice.

   Use page 6 for notes.

Worksheet W-8-2 (page 3 of 6) Name ____________________

CHEMICAL NAME

FORMULA FLASH POINT

KINDS OF HAZARDS	CORROSIVE TO SKIN AND EYES	___	FLAMMABLE	___
	TOXIC BY INGESTION	___	REACTIVE WITH WATER	___
	TOXIC BY INHALATION	___	UNSTABLE	___
	TOXIC BY SKIN CONTACT	___	RADIOACTIVE	___

SEVERITY OF HAZARDS	HEALTH	0	1	2	3	4
	FIRE	0	1	2	3	4
	REACTIVITY	0	1	2	3	4
	SPECIFIC	___				

EMERGENCY TREATMENT

SUPPLIER

DATE PREPARED ____ PURCHASED ____ RECEIVED ____

USAGE

OTHER INFORMATION

Worksheet W-8-2 (page 4 of 6) Name ____________

SAMPLE LABEL FOR SULPHURIC ACID

a. Health Related Statements (Exhibit W-8-5a)

b. Health Hazard Action Statements (Exhibit W-8-5b)

c. Fire Amplifying Statements (Exhibit W-8-5c)

d. Fire Hazard Action Statements (Exhibit W-8-5d)

e. Reactivity Amplifying Statements (Exhibit W-8-5e)

f. Reactivity Hazard Action Statements (Exhibit W-8-5f)

g. First Aid Statements (Exhibit W-8-5g)

h. Statements Specifying Specific Disposal Instructions (Exhibit W-8-5h)

Worksheet W-8-2 (page 5 of 6) Name ____________________

SAMPLE LABELS

A. Teacher transfers some methyl alcohol from a stock bottle to a reagent bottle.

Hazard Signals

1 Health

3 Flammability

0 Reactivity

B. Student prepares 200 ml of a 20% solution of potassium hydroxide for tomorrow's lab.

Hazard Signals

3 Health

0 Flammability

1 Reactivity

C. Describe a labeling problem in a course other than chemistry. Then prepare a label.

Worksheet W-8-2 (page 6 of 6) Name ____________________

NOTES

WORKSHEET W-8-3. TEACHER AND STUDENT RESPONSIBILITIES FOR LABELING

Complete this page and the next page for your school or work area.

NAME ______________________ DATE ________________

TITLE ____

SCHOOL ____

DEPARTMENT _______________________________________

LOCATION: CITY _________________ STATE ________________

---

1. List courses involving materials that require labels.

	Title	No. Materials
a.		
b.		
c.		
d.		
e.		
f.		
g.		

2. Special problems in the above.

Worksheet W-8-3 (page 2 of 2)

PROPOSED LABELING PLAN

Name ____________________

Labeling Activities	Teacher Responsibilities	Student Responsibilities
A. Inventory		
B. Label Data File		
C. Label Preparation		
D. Other		

WORKSHOP ON SAFETY EQUIPMENT

NO. W-13

METHODS Explanation, Practice, and Testing **LENGTH** 2 hours

PURPOSE Provide opportunities for hands-on or first hand experience with safety equipment.

OBJECTIVES Enable the trainee to...

1) Demonstrate a knowledge of the purpose and operation of 10 common pieces of safety equipment.
2) Demonstrate the technique of properly using 10 common pieces of safety equipment.
3) Perceive further needs and requirements for using the equipment in the laboratory.

SPECIAL TERMS

Hazard Control
Hazard Evaluation
Hazard Recognition
Instrumentation
Safety Equipment Checklist

INSTRUCTOR MATERIALS

Lesson Plan
Sample Equipment and Related Supplies

TRAINEE MATERIALS

Lesson Plan (complete)
Sample Equipment and Related Supplies

CONTENTS

INTRODUCTION W-13-3

Safety Equipment Checklist W-13-3

Hazard Recognition or Identification W-13-3

Hazard Evaluation or Measurement W-13-4

Hazard Control or Prevention W-13-5

Directions W-13-6

EXHIBITS

W-13-1. Suggested Items for Safety Equipment Checklist W-13-7

W-13-2. Hazard Recognition "Equipment" W-13-8

W-13-3. Hazard Evaluation Equipment W-13-9

W-13-4. Hazard Control Equipment W-13-10

WORKSHEETS

W-13-1. Safety Equipment Practice W-13-11

432

LESSON Workshop on Safety Equipment NO. W-13

NOTES	INSTRUCTION
	INTRODUCTION
	Instruments and tools are an integral part of a safety program. Throughout this training course, reference is made to equipment and devices used to evaluate (measure) and control (prevent) safety and health hazards in the work or school environments.
	In this lesson, laboratory teachers have a chance to become more familiar with safety equipment and gain experience in actually using 10 common items.
Exhibit W-13-1	Safety Equipment Checklist
	Each science teacher should conduct a regular safety inspection of the laboratory on a daily basis. More thorough inspections should be made at other frequent intervals.
	If the school does not provide checklists, each teacher should prepare suitable forms.
Exhibit W-13-2	Hazard Recognition or Identification
	Safety and health professionals learn to rely on judgment and sensory perception for the initial assessment of hazards.
	In the school science laboratory, the most

LESSON Workshop on Safety Equipment NO. W-13

NOTES	INSTRUCTION
Alert Prepared Teacher (APT)	effective "equipment" for the recognition of safety and health hazards is the Alert Prepared Teacher. We might call him or her the APT.
	The APT learns to use eyes, ears, and nose to identify potential safety and health hazards, applying knowledge, skills, and attitudes about people, the environment, and the products or processes in use.
Exhibit W-13-3	Hazard Evaluation or Measurement
	Chemicals and physical agents constantly pose a threat to safety and health where they are made, used, and stored.
	These risks to safety and health can be greatly reduced by proper management, engineering controls, and personal protective equipment. Quantities can be limited, personnel can be informed in detail about the hazards, and very hazardous materials can be prohibited. However, the work air should also be monitored.
	Measuring devices must be properly maintained and calibrated. Calibration should be continuous, but it is especially important when the devices are received, repaired, and in

LESSON Workshop on Safety Equipment NO. W-13

NOTES	INSTRUCTION

hard use. Other procedures to follow are:

1. Always store in a cool, dry, dust-free, non-corrosive atmosphere.

2. Check battery-operated instruments for full charge before use.

3. Keep records of battery changes, calibration, and maintenance, plus any changes made in the equipment.

4. Study and follow the manufacturers' directions. File in a convenient place. Duplicate for lab use.

Instrumentation in this important aspect of occupational safety and health is mushrooming in quantity and sophistication. Unfortunately, all the equipment on the market does not serve the intended purpose or function well.

In this workshop, teachers will examine the purpose and function of various measuring devices. Such examination and practice with relatively simple items lay the foundations for assessing the cost-effective benefits of future purchases for the school science laboratory.

Exhibit W-13-4

Hazard Control or Prevention

Equipment for preventing injurious accidents or work-related disease and illness is also increasing in availability, due to the impetus of

LESSON Workshop on Safety Equipment NO. W-13

NOTES	INSTRUCTION
OSH Act of 1970/29 CFR 1910	Federal and State laws and regulations for occupational safety and health. Again, however, availability and price do not insure quality. Teachers must learn to look beyond promotional features and gimmicks into real purpose and function. There is help in
See Appendix B and NIOSH Publications List	the technical literature for those who are interested in further study in this area. Directions Specific directions for this lesson will be provided by training supervisors and instructors. However, the general guidelines are: 1. Review the Worksheet to find out what is required. Then study the exhibits. 2. Examine the equipment and complete a separate Worksheet for each piece. 3. Practice using each piece of equipment until you feel confident with the techniques. 4. Arrange with the instructor to be "tested" on the proper use of the equipment. 5. Give your Worksheets to the instructor for signing and recording.

EXHIBIT W-13-1. SUGGESTED ITEMS FOR SAFETY EQUIPMENT CHECKLIST

Item	Classroom	Laboratory	Storeroom
Door(s)			
Window(s)			
Floor			
Cabinet(s)			
Shelving			
Ventilation			
Lighting			
Heat (Above 25°C)			
Water			
Waste Drain			
Fire Extinguisher			
Safety Shower			
Fire Blanket			
Eye Wash			
First Aid Kit			
Fume Hood			
Student Lab Station			
Instructor Preparation Station			
Instructor Demonstration Desk			
Master Water Cut-Off Valve			
Master Electric Cut-Off Switch			
Master Gas Cut-Off Valve			
Chemical Reagents			
Disposition of Hazardous Materials			
Disposition of Unlabeled Materials			
Disposition of Unusable Equipment			
Glassware			
Other			

COMMENTS:

Source: Science Safety. Division of Secondary Education, Department of Education, Commonwealth of Virginia, Richmond, Virginia (July 1976).

EXHIBIT W-13-2. HAZARD RECOGNITION "EQUIPMENT"

Eyes	Knowledge
Ears	Skills
Nose	Attitudes

Alert Prepared Teacher (APT)

EXHIBIT W-13-3. HAZARD EVALUATION EQUIPMENT

Item	Purpose
Combustible Gas Meter	Take air measurements.
Detector Tube System	Indicate presence of hazardous gases and vapors.
Electric Hazard Tester	Evaluate static charge, current leaks, and electrical outlets.
Geiger-Mueller Counter	Measure radioactivity.
Light Meter	Measure levels of illumination.
Noise Meter	Measure sound levels.
Radiation Detector	Measure radiation.
Velometer	Measure air flow.
Ventilation Smoke Tube	Measure air flow direction and rate.
Wind Chimes or Mobiles	Indicate air flow.

EXHIBIT W-13-4. HAZARD CONTROL EQUIPMENT

Item	Purpose
Eyewash Facilities	Prevent or reduce injuries from chemicals.
Fire Blankets	Smother flaming clothes or hair.
Fire Extinguishers	Put out fires.
First Aid Kits	Give emergency treatment for burns, cuts, etc.
Lab Aprons	Protect body and clothing from biological and chemical hazards.
Lab Gloves	Protect hands from laboratory hazards.
Respirators	Prevent inhalation of toxic substances.
Safety Goggles	Protect eyes from chemical and particle injuries.
and	
Face Shields	Protect head, face, and neck from chemical and particle injuries.
Safety Showers	Prevent or reduce injuries from chemicals.
Sand Buckets	Smother small fires.
Tongs	Protect hands from burns and chemical injuries.
Waste Containers	Prevent fires, explosions, and pollution.

WORKSHEET W-13-1. SAFETY EQUIPMENT PRACTICE

Complete this page and the next page for each piece of equipment tried.

YOUR NAME ______________________________ DATE __________

YOUR TITLE ______________________________

SCHOOL ______________________________

DEPARTMENT ______________________________

LOCATION: CITY ______________________ STATE __________

---

1. Description (Complete as many of the blanks below as possible.)
   - a. Name (Generic) ______________________
   - b. Name (Brand) ______________________
   - c. Model, Serial, or other ID Number ______________________
   - d. Maker or Supplier ______________________
   - e. Cost per Unit ______________________

2. What is the equipment supposed to do? (Purpose)

3. How is the equipment supposed to work? (Operation)

4. Does it seem to fulfill its purpose? Yes ___ No ___ ? ___

   Explain.

5. Does it seem to operate properly? Yes ___ No ___ ? ___

   Explain.

Worksheet W-13-1 (page 2 of 2) Name ____________________

---

6. Courses in which the equipment might be used.

	Title	No. Students
a.	______________________________	__________
b.	______________________________	__________
c.	______________________________	__________
d.	______________________________	__________
e.	______________________________	__________
f.	______________________________	__________
g.	______________________________	__________

7. Special problems with the above.

8. Further education/training necessary for classroom use.

   a. Teachers

   b. Students

   c. Other (Administrators, Parents, etc.)

8. Time estimate for you to use the equipment properly with confidence.

   a. Explanation _____ b. Practice _____ c. Testing _____

10. (For Instructors Only) The trainee has satisfactorily demonstrated ...

   a. Knowledge of purpose and operation of equipment.
   b. Technique of proper usage of equipment.
   c. Perception of further needs and requirements.

Name ______________________________ Date ______________

APPENDICES

APPENDIX A - Audio-Visuals

The In-Service Training Program on Safety in the Laboratory for School Science Teachers is based on lectures, workshops, laboratories, and audio-visual sessions. A total of 16 contact hours (50 minutes each) of formal instruction is necessary for teachers to obtain the CS^3 - NIOSH course certificate and 1.6 Continuing Education Units (CEU's).

There is a large universe of safety and health aids directed toward employers and employees. To date, however, only a few seem to have been made especially for school audiences.

Selected audio-visuals are listed in this Appendix. Suggestions for further additions are welcomed and encouraged. Please make suggestions by providing full descriptions to NIOSH via State Science Supervisors and the Council of State Science Supervisors.

SLIDES

A set of slides (35mm) is furnished by NIOSH to each State Science Supervisor, who will reproduce and distribute copies for all local training groups. (Some local rotation of slide sets may be necessary.)

Each slide is numbered in sequence by lesson (1-1, 1-2, etc.) and a slide script is provided at the end of the corresponding lesson material. This script includes small photographic reproductions of the slides, as well as numbers, content descriptions, and titles in some cases.

The NIOSH slides should be used as part of the basic lessons and not as separate audio-visual sessions.

FILMS, FILMSTRIPS, VIDEO CASSETTES, AND SLIDE-TAPE SETS

These training tools may be used as Instructional Aids (those which supplement other course materials, literature, etc.) or as Instructional Media (those which are complete enough to comprise lessons in themselves, and teach without the necessary inclusion of additional information.)

Part 1. of this appendix lists those films, filmstrips, slide-tape sets, and video cassettes which fall into the category of Instructional Media. It is suggested that they be used as independent lessons, or companion lessons, generating discussion from which specific learning objectives should be achieved. It is important, therefore, that the moderator/instructor structure group discussion activities so as to produce results consistent with objectives. More specifically, there should be definite results in the form of lists, suggestions, affirmative action plans, etc. from each A-V session.

Part 2. of the appendix lists films, filmstrips, slide-tape sets, and video cassettes which may be classified as Instructional Aids, indicating that, for our purposes in this course, they should be used to supplement other materials. Although in many instances these aids present principles rather than specific guidelines to safe behavior, they also can be used to generate group discussion from which specific information leading to affirmative action will result.

WORKSHEET A-1, AUDIO-VISUAL CRITIQUE, is designed to help maximize the use of both primary and secondary audio-visual materials. An Audio-Visual Critique should be prepared by each participant or discussion group for each A-V viewed.

The local training supervisors should reproduce sufficient copies of the critique form in advance. These worksheets should be distributed and completed at the showings. They may then be used as a basis for the discussions. The teacher trainees may elect to keep the sheets as a record of intended positive action.

Results of the A-V sessions should be reported to the Council of State Science Supervisors via State Supervisors. The Optional Instructor Worksheet A-2 may be used for this purpose if desired.

The following pages provide an annotated list of loan-free and rental audio-visuals and a list of some of the organizations which offer films, filmstrips, and slide sets for rent or sale.

PART 1

THE ABC'S AND D"S OF PORTABLE FIRE EXTINGUISHERS

Motion Picture, 16 mm, Color, 26 minutes

A step by step description on how to operate and use portable extinguishers, includes how they work and the differences in the various types.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

IN CASE OF FIRE

Motion Picture, 16 mm, Color, 17 minutes

Features the elements of fire, classes of fire and a variety of portable extinguishers.

National Safety Council
Los Angeles Chapter
3388 W. 8th Street
Los Angeles, California 90005

CHEMICAL BOOBY TRAPS

Motion Picture, 16 mm, Color, 13 1/2 minutes

An excellent film which demonstrates the need for personal protection, hoods and other safety devices.

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611 only

Part 1 (con'd)

COMPRESSED GASES...UNDER YOUR CONTROL

Motion Picture, 16 mm, Color, 19 1/2 minutes

Many safety points in the handling of compressed gases are covered in this film. It is a good "discussion starter" into the safety policies of your particular industry or institution.

Matheson Gas Products
P. O. Box 85
E. Rutherford, New Jersey 07073

EYE AND FACE PROTECTION IN CHEMICAL LABORATORIES

Motion Picture, 16 mm, Color, 22 minutes or 13 1/2 minutes

A film which illustrates the violence of chemical explosions and their danger to person and property. Ways are suggested for making the laboratory safer.

National Society for the
Prevention of Blindness
- State Chapters
or
79 Madison Avenue
New York, N. Y. 10016

LABORATORY SAFETY - Part I

Motion Picture, 16 mm, Sound, 20 minutes

This excellent film was produced by the Virginia State Department of Education. It is one of the very few films which directly addresses the school laboratory safety issue.

NIOSH will supply one copy to each State

Contact your State Science Supervisor or other designated responsible State Officer.

Part 1 (con'd)

LAB SAFETY

16 mm, Color, 12 minutes

Shows methods of avoiding accidents in chemical laboratories and outlines procedures to follow when accidents occur.

University of California
Extension Media Center
2223 Fulton Street
Berkeley, California 94720

LASER SAFETY

Motion Picture, 16 mm, Color, 18 minutes

Vividly illustrates hazards involved in using lasers and shows what can be done to prevent injuries to eyes and skin. The film explains the four properties that make lasers a useful tool but can also combine to destroy biological tissue. An excellent film.

National Audio Visual Center
Washington, D.C.
or
University of California
Extension Media Center
2223 Fulton Street
Berkeley, California 94720

LASER SAFETY

Filmstrip/tape, Color, 13 minutes

Describes eye damage and skin burns as well as secondary hazards such as electrical shock and chemical exposure.

NIOSH
Office of Technical Publications
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, Ohio 45226

RESEARCH LABORATORY SAFETY

Slide/tape, 10 minutes

A well designed cartoon type illustrated package on general procedures for safe laboratory operation.

NIOSH will furnish 1 copy to each State

Contact your State Science Supervisor or other designated responsible State Officer.

Or available for rental:

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611

SAFE HANDLING OF LABORATORY ANIMALS

Motion Picture, 16 mm, Sound, 15 minutes

Demonstrates the techniques of handling and emphasizes methods of avoiding injury and infections.

National Medical Audio Visual Center
National Library of Medicine
refer to M-455 Atlanta, Georgia 30324

SAFETY ATTITUDES

Motion Picture, 16 mm, Color, 10 minutes

Describes the causes and effects of unsafe attitudes. Illustrates that attitudes are learned, not inherited.

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611
or
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

SAFETY IN THE CHEMICAL LABORATORY

Motion Picture, 16 mm, Color, 20 minutes

Safe practices when using chemicals in the laboratory are explained with special emphasis on the handling of flammables. .....Accompanied by a teacher's guide.

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611
or
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

SAFETY IN THE SCIENCE LAB - A Series

Video cassette 3/4" U-matic, 15 minutes each

1. Introduction
2. Handling Glassware Properly
3. Proper Eye Protection
4. Electrical Hazards
5. Legal Liability
6. Fire Protection and Prevention
7. Elementary First Aid

This series was developed and produced under the sponsorship of the N.E. Tennessee Section of the American Chemical Society in Cooperation with WSJK-TV, Knoxville, especially for the in-service training of junior and senior high school teachers of Upper East Tennessee.

Available on loan only from
Dr. George J. O'Neill
Research Labs
Tennessee Eastman Company
Kingsport, Tennessee 37662
or contact:
Glenda White
Div. of Training & Manpower Development
National Institute for Occupational
Safety and Health
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, Ohio 45226

Part 1 (con'd)

TAKE YOUR CHOICE

Motion Picture, 16 mm, Color, 13 minutes

A good film to generate discussion. Set in a high school chemistry laboratory, a student believes that accidents happen only to other people.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

28 GRAMS OF PREVENTION

Motion Picture, 16 mm, Color, 25 minutes

An excellent film on lab safety which covers the various aspects of safety such as labels, safety devices, storage, fire extinguishers, classes of fire, sprinkler or alarm systems, first aid, personal protective devices, disposal and electric shock.

Fisher Scientific Company
711 Forbes Avenue
Pittsburgh, Pa. 15219
or contact:
Glenda White
Div. of Training & Manpower Development
National Institute for Occupational Safety and Health
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, Ohio 45226

WORKING WITH COMPRESSED GASES

Motion Picture, 16 mm, Color, 20 minutes

Demonstrates safe handling of compressed gases in industry and research.

Matheson Gas Products
P. O. Box 85
E. Rutherford, New Jersey 07073

PART 2

THE ACCIDENT BUG

Motion Picture, 16 mm, Color, 25 minutes

A crash course in the Occupational Safety and Health Act. Directed at employers, this film stresses the importance of proper record-keeping as required under the Occupational Safety and Health Act.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

BARE MINIMUM

Motion Picture, 16 mm, Color, 10 minutes

Demonstrates the value of personal protective equipment. This film is one of a Safety Management Film Series intended to provide foremen and supervisors with training in the basic areas of accident prevention.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

BE A PRO

Motion Picture, 16 mm, Color, 15 minutes

Stresses that just as professional athletes protect themselves with good equipment and attitudes, workers too should develop a professional attitude toward safety.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

EXPEDITE - SCHOOL EYE SAFETY

Motion Picture, 16 mm, Color, 12 minutes

Illustrates eye hazards in school chemistry labs, industrial art classes and shops, with specific eye safety equipment recommended.

National Society for Prevention
of Blindness
State Chapter
or
79 Madison Avenue
New York, New York 10016

FIRST AID SERIES:

Motion Picture, 7 films, 16 mm, Color, 7-10 minutes each

1. Artificial Respiration
2. Control of Bleeding
3. Physical Shock
4. Open and Closed Wounds
5. Burns and Scalds
6. Fractures and Dislocations
7. Transportation

These films are an introduction to effective first aid procedures. The titles are self-explanatory.

Also available in Spanish

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611
or
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

Part 2 (con'd)

NO SECOND CHANCE

Motion Picture, 16 mm, Color, 23 minutes

A good film for general safety information and more specifically covering peroxide safety relevant to the polyester industry.

Sellstrom Manufacturing Company
Sellstrom Industrial Park
P. O. Box 355
Palatine, Illinois 60067

PULSE OF LIFE

Motion Picture, 16 mm, 28 minutes

A good demonstration of Artificial Respiration and Artificial Recirculation.

National Safety Council
425 N. Michigan Avenue
Chicago, Illinois 60611 only
or contact:
Glenda White
Div. of Training and Manpower Development
National Institute of Occupational Safety and Health
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, Ohio 45226

READ THE LABEL AND LIVE

Motion Picture, 16 mm, Color, 9 minutes

Explains why warning labels should be read; how to distinguish between more and less hazardous substances. Examples are directed at the general audience and emphasizes substances found around the home.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

Part 2 (con'd)

A SAFE BET

Motion Picture, 16 mm, Color, 20 minutes

A serious yet entertaining safety training film demonstrates that carelessness and unsafe practices are gambles as much as dice, cards and even Russian roulette.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

SAFETY - A WAY OF LIFE

Motion Picture, 16 mm, Color, 21 minutes

Safety is dependent on safe attitudes at work and on the highway. This film is a discussion generator.

U.S. Department of Labor
MESA
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

SCHOOL INSPECTION SAFETY

35 mm Slide-tape

This slide series gives general and basic information relating to school safety. Content is good.

Workmen's Compensation Board
APD, Film Library
Labor & Industries Bldg.
Salem, Oregon 97310

STRAIGHT TALK ON EYE SAFETY

Motion Picture, 16 mm, Color, 12 1/2 minutes

A filmed interview emphasizes "prevention." It is a plea to schools and industry on the need for eye and face protection.

National Society for Prevention
of Blindness
- State Chapters
or
79 Madison Avenue
New York, New York 10016

TALK IT UP

Motion Picture, 16 mm, Color, 10 minutes

One of a 3-film communicating safety series, this film stresses the fact that successful supervisors are committed to safety. It depicts various methods of motivating others to join that commitment.

National Safety Council
Los Angeles Chapter of NSC
3388 W. 8th Street
Los Angeles, California 90005

TOXIC CHEMICAL AGENTS...Physiological Effects

Video Cassette 3/4" U-Matic

An excerpt from the film, "Toxic Chemical Agents," produced by the U.S. Air Force.

Glenda White
Div. of Training and Manpower Development
National Institute for Occupational
Safety and Health
Robert A. Taft Labs
4676 Columbia Parkway
Cincinnati, Ohio 45226

WINDOWS OF YOUR SOUL

Motion Picture, 16 mm, Color, 28 minutes

"Windows" is an older but stirring film which features the late Senator Everett M. Dirksen pointing up the importance of wearing face and eye protection in school shops, labs and industry.

Sellstrom Manufacturing Company
Sellstrom Industrial Park
P. O. Box 355
Palatine, Illinois 60067

ORGANIZATIONS PROVIDING RENTAL OR SALE FILMS AND FILMSTRIPS DEALING WITH OCCUPATIONAL SAFETY AND HEALTH

Abbott Laboratories
Professional Relations Department
Abbott Park
North Chicago, IL 60064

Aetna Life & Casualty
151 Farmington Avenue
Hartford, CT 06115

American Gas Association
1515 Wilson Boulevard
Arlington, VA 22209

American Heart Association
Distribution Dept.
44 E. 23rd St.
New York, NY 10010

American Hospital Association
840 North Lake Shore Drive
Chicago, IL 60611

American Optical
Box 1
Southbridge, MA 01550

Area 16/Cinesound
915 N. Highland
Hollywood, CA 90038

Association-Sterling Films
866 Third Avenue
New York, NY 10022
(Free Catalogs Available Upon Request)

The Atchison, Topeka & Santa Fe
Railway Co.
80 E. Jackson Blvd.
Chicago, IL 60604

Better Vision Institute
230 Park Avenue
New York, NY 10017

Bray Studios
630 Ninth Avenue
New York, NY 10036

The Bureau of Business Practice
24 Rope Ferry Rd.
Waterford, CT 06385

Close Productions, Inc.
2020 San Carlos Boulevard
Fort Myers Beach, FL 33931

Creative Communications, Inc.
13900 Panay Way
Marina del Rey, CA 90291

John V. Dunigan Studios
208-5th Avenue
New York, NY 10010
(Catalogue available)

Fisher Scientific Company
711 Forbes Avenue
Pittsburgh, PA 15219

Factory Mutual
1151 Boston-Providence Turnpike
Norwood, MA 02062
(Fire films only)

Federal Aviation Administration
P. O. Box 25082
Oklahoma City, OK 73125

Edward Feil Productions
1514 Prospect Avenue
Cleveland, Ohio 44115

The Fertilizer Institute
1015 - 18th St., NW
Washington, DC 20036

General Electric Educational Films
Corporations Park
Bldg. 705
Scotia, NY 12302

The Greater Chicago Safety Council
10 North Clark St.
Chicago, IL 60602

Greater Los Angeles Chapter
National Safety Council
3388 West 8th St.
Los Angeles, CA 90005

Harvest Films
309 Fifth Avenue
New York, NY 10016

Hyster Co.
P.O. Box 2902
Portland, OR 97208

Indiana University
Audio-Visual Center
Bloomington, IN 47401

International Film Bureau, Inc.
332 S. Michigan Avenue
Chicago, IL 60604

International Medifilms
3491 Cahuenga Boulevard
Los Angeles, CA 90068

Iowa State University
Fire Service Extension
Ames, IA 50010

Library Filmstrip Center
3033 Aloma
Wichita, Kansas 67211

J.F. Lincoln Arc Welding Foundation
P.O. Box 3035
Cleveland, Ohio 44117

Lineman's Supply Division
P.O. Box 1690
Binghamton, NY 13902

MacMillan Films
34 MacQuesten Parkway, South
Mount Vernon, N.Y. 10550

Manufacturing Chemist Assn.
1825 Connecticut Avenue, NW
Washington, DC 20009

Marshall Maintenance
529 South Clinton Avenue
Trenton, NJ 08611

Middle West Service Co.
69 Washington St.
Chicago, IL 60602

Mogull's
235 W. 46th St.
New York, NY 10010

National Educational Media, Inc.
15250 Ventura Blvd.
Sherman Oaks, CA 91403

The National Film Board of Canada
1251 Avenue of the Americas
New York, NY 10020
(Address for catalogue only)

National Restaurant Association
One IBM Plaza
Suite 2600
Chicago, IL 60611

National Rural Electric Cooperative
2000 Florida Avenue, NW
Retirement Safety & Insurance Dept.
Washington, DC 20009

National Society for Prevention
of Blindness
79 Madison Avenue
New York, NY 10016

National Safety Council
425 N. Michigan Avenue
Chicago, IL 60611

New England Health Resource Center
Dept. of Media Services
University of New Hampshire
Durham, NH 03824

New York State College of
Agriculture & Life Science
Cornell University
Roberts Hall - Film Library
Ithaca, NY 14850

The Ohio State University
Film Library
Dept. of Photography & Cinema
156 W. 19th Avenue
Columbus, OH 43210

The Pennsylvania State University
Audio-Visual Service
176 Willard Building
University Park, PA 16802

Scott Education
Customer Service
104 Lower Westfield Rd.
Holyoke, MA 01040

Southern Pacific Transportation
Company
Audio-Visual Center
475 Brannan St.
San Francisco, CA 94107

U.S. Dept. of Agriculture
Office of Communication
Washington, DC 20250

Universal Education & Visual Arts
100 Universal City Plaza
Universal City, CA 91608

University of Kansas
Audio-Visual Center
746 Massachusetts St.
Lawrence, KN 66044

University of Michigan
Audio-Visual Education Center
416 Fourth St.
Ann Arbor, MI 48103

Visual Education, Inc.
1425 H. St., NW
Suite 424 - Southern Bldg.
Washington, DC 20005

Wilson Products Division
P.O. Box 622
Reading, PA 19603

Xerox Films
245 Long Hill Rd.
Middletown, CT 06457

WORKSHEET A-1. TRAINEE AUDIO-VISUAL CRITIQUE

Complete this page and the next page for each audio-visual reviewed.

Your Name ______________________________ Date ____________

Your Title ____

School ____

Department ____

Location: City ____________________________ State ____________

DESCRIPTION

Title: ____

Medium: Film ____, Filmstrip ____, Video Cassette ____, Slide-Tape Set ____

---

1. Most important messages conveyed, from your point of view. Please be specific.

2. List the most important things you should be able to do as a result of reviewing this A-V.

Worksheet A-1 (page 2 of 2) Name ______________________________

3. Were these ideas new to you? Yes_____ No_____

4. Will you make any changes toward safe practices in your lab as a result of reviewing this A-V? Yes_____ No_____

Explain.

5. Comments

WORKSHEET A-2. INSTRUCTOR AUDIO-VISUAL CRITIQUE (OPTIONAL)

Complete both pages and return to NIOSH via CS^3.

Your Name ______________________________ Date ______________

Your Title ______________________________

School or Organization ______________________________

Address ______________________________

____

DESCRIPTION

Title ______________________________

Medium: Film_____, Filmstrip_____, Video Cassette_____, Slide-Tape Set________

Length (minutes or frames)______________ Date prepared (if known)__________

Color?__________ Sound?__________ Graphics?__________

Producer or Distributor ______________________________

1. Most important messages conveyed, from your point of view. Please be specific.

2. In your opinion, what kind of group would benefit from the use of this A-V? (General Science, Specific Disciplines, etc.)

Worksheet A-2 (page 2 of 2) Name ______________________

3. Did the use of this A-V generate an active discussion resulting in the dissemination of useful information? Please explain.

4. Circle the letters of applicable elements below and rate each of these as shown.

	Good	Fair	Poor
a. Length	____	____	____
b. Color	____	____	____
c. Sound	____	____	____
d. Legibility of Graphics	____	____	____
e. Treatment of Subject Matter	____	____	____
f. Suitability for Students	____	____	____
g. Suitability for Teachers	____	____	____
h. Suitability for Parents	____	____	____
i. Overall Quality	____	____	____

j. Other (specify) ______________________

5. Comments

APPENDIX B - LIBRARY RESOURCES

Subject matter for the In-Service Training Program for High School Science Teachers is drawn from a vast and growing body of literature in the field of occupational safety and health. There are countless books, periodicals, and publications of many kinds in all aspects of related disciplines.

So far, there appears to be very little published material that addresses the special problems of schools and classrooms. This is sure to come in the near future. Meanwhile, much of the industrially-oriented literature can be used for reference, with some adaptation and interpretation.

The problem is to choose the most appropriate sources from a very large universe of possibilities. Selection criteria should include availability, reliability, and cost.

A few basic references are suggested on the next pages, followed by several others of a more specialized nature. At least the basic items should be in the library of every school science department. The following article provides a more comprehensive list by major topics and includes journals and other sources of information:

> Carnow, B.W., et al. "A Bookshelf on Occupational Health and Safety," American Journal of Public Health, 65:503-520 (May 1975).

Reprints of the above are available only in quantity from the American Public Health Association, 1015 - 18th Street, NW Washington, D.C. 20036. The minimum order is 100 copies for about $90 (as of June 1977). A Copy of this reprint will be provided by NIOSH to each State Supervisor.

Good "starter" periodicals are:

> College & University Newsletter 412.01 5 issues per subscription.
> $2.15

Chemical Newsletter. 112.01, 12 issues per subscription which includes a volume of the National Safety Congress Transactions. $3.40

Both of the above are available from the National Safety Council, 425 North Michigan Ave., Chicago, Ill. 60611.

Another periodical for your consideration is Job Safety & Health, the official magazine of the U. S. Occupational Safety and Health Administration (OSHA). It is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price is $13.6- in the U. S.

BASIC REFERENCES

Accident Prevention Manual for Industrial Operations. Seventh Edition. National Safety Council, Chicago, Illinois (1974). $30.00

Aldrich Chemical Co. Catalogue. Aldrich Chemical Co., 940 W. St. Paul Ave., Milwaukee, Wisconsin 53233 No Charge.

CRC Handbook of Laboratory Safety. Second Edition., Norman V. Steere, Ed. Chemical Rubber Co., Cleveland, Ohio $33.95

Chemical and Biological Safety Guide. U. S. Department of Health, Education and Welfare, National Institutes of Health. Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. Stock No. 174000383 $3.85

Fisher Safety Manual. Fisher Scientific Co., 711 Forbes Ave., Pittsburgh, PA. 15219 No Charge.

Industrial Safety Data Sheets & Chemical Safety Guides. National Safety Council, Chicago, Illinois Charges vary according to quantity ordered.

Laboratory Waste Disposal Manual. new edition available after January 1978. Manufacturing Chemists Association, 1825 Connecticut Ave., Washington, D.C. 20009 $5.50

MCB Chemical Reference Manual, Volume II. MCB Chemical Co., 2909 Highland Ave., Norwood, Ohio 45212 No Charge.

Merck Index. Merck & Co., Inc., Rahway, N.J. $18.00

Registry of Toxic Effects of Chemical Substances. HEW Publication No. (NIOSH) 76-191. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402 $13.00

Safety in the Academic Chemistry Laboratory. American Chemical Society, 1155 16th St., N.W., Washington, D. C. 18042. 5 or less free

Safety in the Chemical Laboratory. Norman V. Steere, Ed., reprints in 3 volumes. Division of Chemical Education, American Chemical Society, Easton, PA. 18042 $5.50 - $6.50 ea.

Prices listed are as of June 30, 1977

OTHER USEFUL REFERENCES

American National Safety Standard Practice for Occupational and Educational Eye and Face Protection. ANSI Z87.1-1968. American National Standards Institute, New York, N.Y. (1968)

Code of Federal Regulations, Title 29, Part 1910. "Occupational Safety and Health Standards". U.S. Occupational Safety and Health Administration. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Communications for the Safety Professional. R.B. Konikow and F.E. McElroy: National Safety Council, Chicago, Illinois (1975)

Dictionary of Terms Used in the Safety Profession. W.F. Tarrants: American Society of Safety Engineers, Park Ridge, Illinois (1972)

Essentials of Toxicology. Second Edition. T.A. Loomis: Lea & Febiger, Philadelphia, Pennsylvania (1974)

Fundamentals of Industrial Hygiene. J.B. Olishifski and F.E. McElroy, Eds: National Safety Council, Chicago, Illinois (1971)

Guide for Safety in the Chemical Laboratory. Second Edition. Manufacturing Chemists' Association: Van Nostrand Reinhold Company, New York, N.Y. (1972) (a portion of this is reproduced in the Laboratory Waste Disposal Manual listed under Basic References)

Hazardous Materials Handbook. Beverly Hills, California: Glencoe Press (1972)

The Industrial Environment - Its Evaluation and Control. National Institute for Occupational Safety and Health (NIOSH): U.S. Government Printing Office, Washington, D.C. (1973)

Industrial Ventilation: A Manual of Recommended Practice. Fourteenth Edition. American Conference of Governmental Industrial Hygienists: Committee on Industrial Ventilation, P.O. Box 16153, Lansing, Michigan 48901 (1976)

Lab Data. Quarterly. Underwriters Laboratories, Inc. 207 E. Ohio St., Chicago, Illinois 60611

Manual of Hazardous Chemical Reactions. NFPA No. 491M. National Fire Protection Association, Boston, Massachusetts (1975)

TLVs: Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes. American Conference of Governmental Industrial Hygienists.: ACGIH, P.O. Box 1937, Cincinnati, Ohio 45201 (latest annual edition)

Other Useful References continued

U.S. Occupational Safety and Health Act of 1970. Public Law 91-596, 91st Congress, S. 2193 (December 29, 1970). No Charge

APPENDIX C - DIRECTORY OF RESOURCES

Additional resources abound for interested participants in the In-Service Training Program on Safety in the School Science Laboratory. As with the literature, the problem is to select the most useful resources from a multitude of individuals and organizations in business, government at all levels, and education.

Business

Large manufacturers and major industries usually employ full-time or part-time safety and health professionals. For leads, consult local telephone directories and the Chamber of Commerce.

Government

All States and most Counties and Municipalities offer some services in safety and health. Start with the local telephone directory, looking for such agency names as labor, occupational safety and health, and public health.

The U.S. National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have regional offices in 10 cities: Atlanta, Boston, Chicago, Dallas, Denver, Kansas City, New York, Philadelphia, San Francisco, and Seattle. OSHA also has area offices in other large cities.

NIOSH headquarters are in the Department of Health, Education, and Welfare in Rockville, Maryland (administrative offices) and Cincinnati, Ohio (research and training laboratories). OSHA headquarters are in the Department of Labor in Washington, D.C.

Education

Many major universities and some community colleges offer academic and continuing education programs in occupational safety and health or related disciplines. Faculty members may be available as resource persons.

Other Resources

Professional societies, service agencies, and trade associations are also active in many facets of occupational safety and health.

Insurance companies and associations may be overlooked by newcomers in the field, but they have been heavily involved for many years.

. . .

The pages that follow contain a beginning list of national organizations that provide a variety of safety and health services. Many of these have local chapters or offices.

A more thorough list, annotated and organized by type of organization, is presented in the following:

> "Sources of Help," Accident Prevention Manual for Industrial Operations. Seventh Edition. National Safety Council, Chicago, Illinois (1974), Chapter 23, pp. 591-630.

A guide to finding the right help is included in the above.

Reminder

In contacting potential sources of help, be sure to explain needs and interests. In making a general inquiry about available materials and services, avoid asking for "everything you have on safety and health".

Name and Address	Abbreviation	Type of Organization
AMERICAN ASSOCIATION OF INDUSTRIAL NURSES 79 Madison Avenue New York, N. Y. 10016	AAIN	Professional Society
AMERICAN CHEMICAL SOCIETY 1155 - 16th Street, NW Washington, D. C. 20036	ACS	Professional Society
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS P. O. Box 1937 Cincinnati, Ohio 45201	ACGIH	Professional Society
AMERICAN INDUSTRIAL HYGIENE ASSOCIATION 66 South Miller Road Akron, Ohio 44313	AIHA	Professional Society
AMERICAN INSURANCE ASSOCIATION Engineering and Safety Services 85 John Street New York, N. Y. 10038	AIA	Insurance
AMERICAN LUNG ASSOCIATION 1740 Broadway New York, N. Y. 10019	ALA	Service
AMERICAN MUTUAL INSURANCE ALLIANCE 20 North Wacker Drive Chicago, Illinois 60606	AMIA	Insurance
AMERICAN NATIONAL RED CROSS Safety Services 17th and D Streets, NW Washington, D. C. 20006	ANRC	Service
AMERICAN NATIONAL STANDARDS INSTITUTE 1430 Broadway New York, N. Y. 10018	ANSI	Standards and Specifications
AMERICAN PUBLIC HEALTH ASSOCIATION 1015 - 18th Street, NW Washington, D. C. 20036	APHA	Professional Society
AMERICAN SOCIETY FOR TESTING AND MATERIALS 1916 Race Street Philadelphia, Pennsylvania 19103	ASTM	Standards and Specifications

Name and Address	Abbreviation	Type of Organization
AMERICAN SOCIETY OF SAFETY ENGINEERS 850 Busse Highway Park Ridge, Illinois 60068	ASSE	Professional Society
INDUSTRIAL SAFETY EQUIPMENT ASSOCIATION 2425 Wilson Boulevard Arlington, Virginia 22201	ISEA	Trade Association
MANUFACTURING CHEMISTS' ASSOCIATION 1825 Connecticut Avenue, NW Washington, D. C. 20009	MCA	Trade Association
NATIONAL FIRE PROTECTION ASSOCIATION 470 Atlantic Avenue Boston, Massachusetts 02210	NFPA	Fire Protection
NATIONAL SAFETY COUNCIL 425 North Michigan Avenue Chicago, Illinois 60611	NSC	Service
NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS 79 Madison Avenue New York, N. Y. 10016	NSPB	Service
UNDERWRITERS LABORATORIES, INC. 207 East Ohio Street Chicago, Illinois 60611	UL	Fire Protection

APPENDIX D - PROGRAM EVALUATION

The success of the In-Service Training Program on school laboratory safety depends on many factors, but State and Local Science Supervisors clearly have the heaviest responsibility for effective implementation.

Teacher trainers need great flexibility in planning, conducting, and evaluating the proposed programs in their districts. However, in order to assess the effort as a whole, some basic measurements should be taken and reported to NIOSH via the Council of State Science Supervisors.

Trainee Critiques

Many supervisors will have their own "standard" evaluation instruments and procedures for teacher training. Others may prefer to develop their own on an *ad hoc* basis. In any case, some kind of written critique is strongly recommended for all participants who complete the program. Teacher comments are also needed to improve and expand future training. It is well to remember that anonymity generally results in more frank opinions from respondents.

Summary Reports

The Council of State Science Supervisors should be kept informed on the progress of the training program and on any special problems that arise. A quarterly report is recommended for the school year 1977-1978. Afterwards, an annual report at the end of the school year should suffice.

Information to be included in the summary reports is listed on the next page. Also listed are possible items to be evaluated by means of formal or informal critiques.

A sample certificate for satisfactory completion of the course is shown in Exhibit D-1. Certificates will be issued by CS^3 and NIOSH *after* summary reports are received from training supervisors.

Recommended Topics for Summary Reports

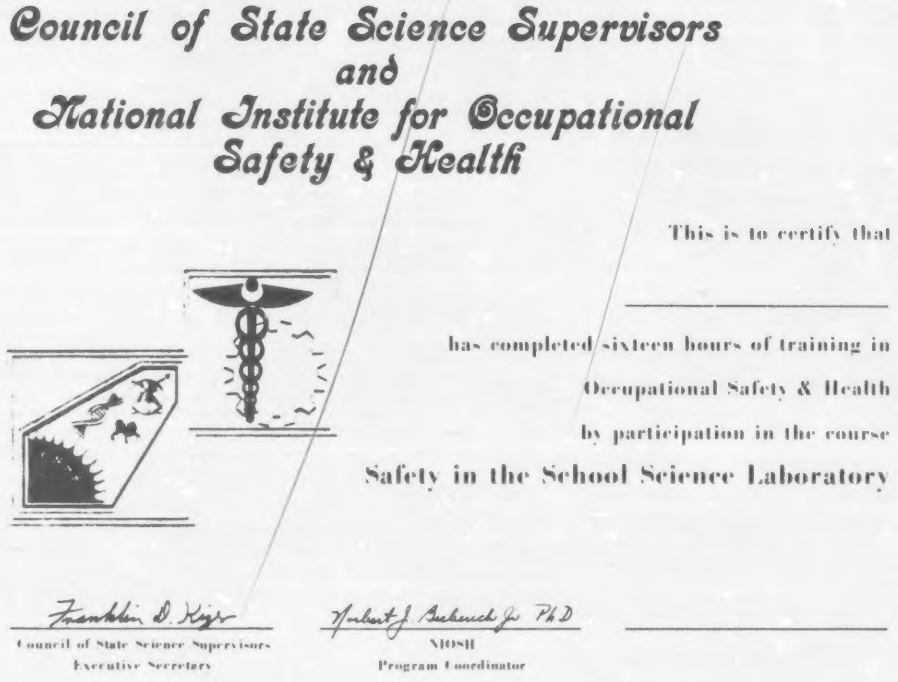
- Numbers and Dates of Enrollments (by Location)
- Numbers and Dates of Completions (by Location)
- Overall Evaluation of Instructional Materials and Methods
- Most Frequent or Important Comments of Participants (including errata)
- Future Needs

Suggested Topics for Further Evaluation

- Achievement of Participant Objectives
- Achievement of Stated Objectives
- Administrative Arrangements
- Audio-Visual Aids
- Best-liked or Most Valuable Features (Strengths)
- Format and Style
- Instructors and Resource People
- Least-liked or Least Valuable Features (Weaknesses)
- Lecture Lessons
- Length
- Less Coverage or Emphasis (Topics)
- Manuals and Handouts (including Lesson Plans)
- More Coverage or Emphasis (Topics)
- Objectives
- Quizzes and Tests (if used)
- References and Resources
- Safety Equipment Selection
- Supplementary Material (if used)
- Topical Organization
- Workshop Lessons

EXHIBIT D-1. SAMPLE TRAINING CERTIFICATE

(50% Reduction)



Council of State Science Supervisors
and
National Institute for Occupational Safety & Health

This is to certify that

____

has completed sixteen hours of training in

Occupational Safety & Health

by participation in the course

Safety in the School Science Laboratory

Franklin D. Kizer
Council of State Science Supervisors
Executive Secretary

Norbert J. Berkench Jr PhD
NIOSH
Program Coordinator

____

APPENDIX E - WALK-THRU SURVEY

The following is a Laboratory Safety Check List which may be used by teachers to:

a. determine whether or not a safe environment exists

b. indicate possible areas of concern and danger

c. serve as a guide for the design of safe facilities

d. act as a monitoring device for periodic safety checks

e. act as a permanent record of an ongoing safety program.

WALK-THRU SURVEY OF THE SCHOOL SCIENCE LABORATORY

Complete the following pages for your school. If desired, send copies to your principal, superintendent, and state science supervisor. Be sure to keep one copy on file for yourself. Repeat at least annually.

NAME ______________________________ DATE ________________

TITLE ____

SCHOOL ____

DEPARTMENT ____

LOCATION: CITY ____________________________ STATE ______________

---

1. Number of Science Teachers in the Department ______________

2. Number of Science Teachers with Safety Training ______________

3. Number of Science Laboratories ______________

4. a. Recommended Student Capacity ______________

   b. Actual Student Capacity ______________

5. Number of Science Classrooms ______________

6. Number of Combined Science Classroom/Laboratories ______________

7. a. Number of Exits per Laboratory ______________

   b. Locate Exits by Layout Diagram (Attach) ______________

   c. Are Exits properly marked? Yes ______ No ______

   d. Are Storage Rooms properly marked? Yes ______ No ______

8. Number of Fire Extinguishers

Type		Location
a. CO_2	________	______________________________
b. Soda Acid	________	______________________________
c. BC	________	______________________________
d. ABC	________	______________________________
e. Water	________	______________________________

Name ______________

9. Number of backup units in storage ______________

10. Last Inspection Date for Fire Extinguishers ______________

11. Number of Sand Buckets w/Sand ______________

12. Number of Approved Fire Blankets ______________

13. Number of First Aid or Emergency Charts ______________

14. Number of First Aid Kits w/Supplies ______________

15. Number of Safety Showers____Are they operable? ______________

    a. Industrial Type ______________

    b. Hand or Portable Type ______________

16. Number of eyewash stations ______________

    a. Installed w/plumbing and aerifier ______________

    b. Squeeze-bottle type ______________

    c. Other ______________

17. Are they checked regularly to determine operability? Yes ______ No ______

18. Eye, Face and Body Protection

    a. Number of approved safety glasses w/full side shields ______________

    b. Number of approved safety chemical goggles ______________

    c. Number cf approved plastic face shields ______________

    d. Number of demonstration safety shields ______________

19. a. Does each student have his/her own personal eye protection device? Yes ______ No ______

    b. If answer is No, is there a maintenance and cleaning program? Yes ______ No ______

20. Number of rubber gloves ______________

21. Number of rubber/plastic/cloth aprons ______________

22. Number of asbestos gloves (pairs) ______________

Walk-Thru Survey (page 3 of 5) Name ____________________

23. Number of lab coats ____________________

24. Number of electric outlets (110-120 volt w/ground) ____________________

25. Number of electric outlets (110-120 volt without ground) ____________________

26. Is provision made for proper grounding of all electrical devices? Yes ______ No ______

If no, please describe ____

27. a. Number of compressed gas cylinders ____________________

b. Are they properly secured to prevent tipping? Yes ______ No ______

28. Number of sinks ____________________

29. Number of waste receptacles for glass ____________________

30. Number of waste receptacles for dry chemicals/reagents ____________________

31. Number of waste receptacles for liquid chemicals/reagents ____________________

32. Number of containers designed to transport dangerous reagents or chemicals. ____________________

33. Are all waste receptacles properly marked? ____________________

34. Are all waste receptacles easily located? ____________________

35. Number of securable storage spaces for chemicals w/forced ventilation ____________________

36. Number of securable storage spaces for chemicals without forced ventilation ____________________

37. Number of electric refrigerators ____________________

Walk-Thru Survey (page 4 of 5) Name ____________

38. Briefly describe what type of materials are stored in these units, such as reagents, food, etc.

____

____

39. a. Number of fume hoods ____________

b. Rated exhaust velocity - cfm if known ____________

40. a. Number of exhaust fans ____________

b. Rated exhaust velocity ____________

41. Is fume hood rated explosion proof? ____________

42. Number of drinking fountains in science rooms ____________

43. Number of drinking fountains in science labs ____________

44. Is there a master cutoff for water? ____________

45. Is there a master cutoff for gas? ____________

46. Is there a master cutoff for electricity? ____________

47. Are they accessible? ______ Do you know where they are? ____________

48. Are the floors non-skid? ____________

49. Is there sharp-edged furniture in the lab? ____________

50. Number of special cabinets to store hazardous or flammable chemicals ____________

51. a. Number of gas burners ____________

b. Number of alcohol burners ____________

c. Number of candles if used ____________

52. Do you use animals in the lab? ______ If so, are there proper facilities to handle them? ____________

53. Are you aware of the biohazards involved in animal handling? Yes _______ No _______

54. a. Are experiments conducted using biologic fluids? ____________

b. What is the source? ____________

Walk-Thru Survey (page 5 of 5) Name ____________________

55. a. Does blood-letting experimentation take place? ____________________

b. If so, are disposable lancets and alcohol swabs used? ____________________

56. Do you permet handling of pathogens by students? ____________________

If yes, explain ____________________

57. Do you have pipette bulbs for proper pipetting procedures? ____________________

58. Is food preparation/consumption/storage permitted in laboratory? ____________________

59. Do you have proper facilities to accommodate the handicapped student? ____________________

Explain Below ____________________

60. Do you have field manuals or explanatory sessions describing possible dangers involved with field trips? ____________________

61. Do you feel properly trained to conduct safe and healthful science laboratory experimentation in your school? ____________________

If no, contact your state science supervisor concerning available training.

OTHER COMMENTS

APPENDIX F - TRAINEE EVALUATION

Reserved for supplemental instruments, test items, and the like to be added later by CS^3, NIOSH, and training personnel.

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